

The Blast Furnace *and* Steel Plant

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The College Graduate

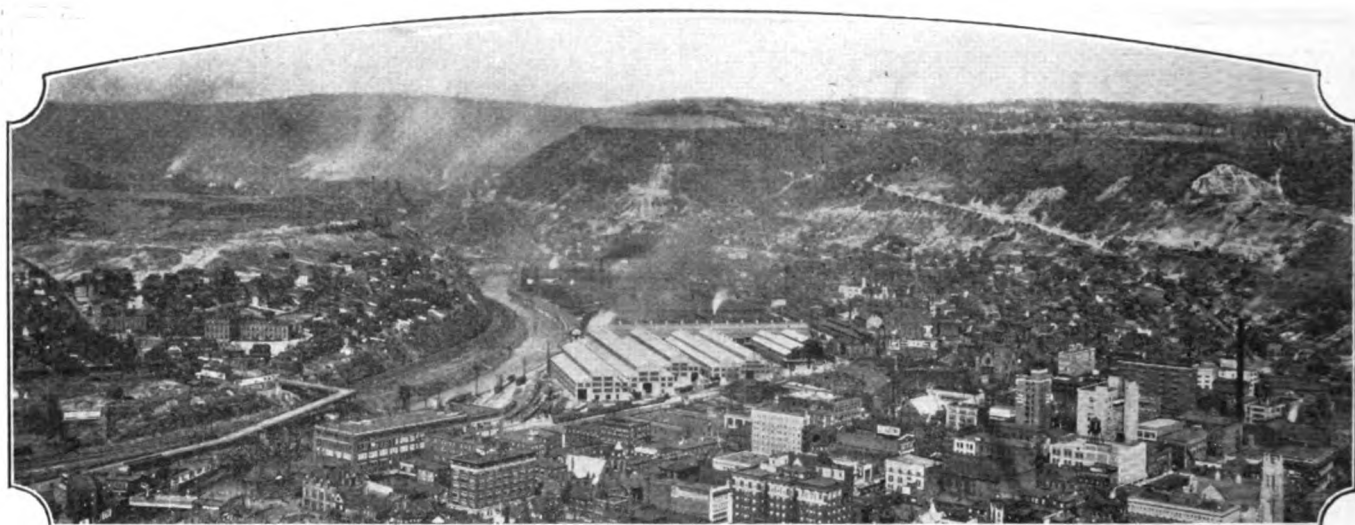
MANY young men have recently graduated from our colleges and universities to follow their professions in the various engineering industries. Quite a number of these men have an exaggerated idea of what they are capable of achieving, a condition brought about largely by their newly developed reasoning faculties. They rest their self esteem upon the things they are going to perform.

In later years they will realize the difference between intentions and accomplishments. One's success is measured only by the things that he has accomplished and not by the things that he expects to do. The task that is not accomplished is of no service to the world.

The value of a college education is not to be underestimated, but the graduate must remember that his success is not assured by a high scholastic record. However, if he has the will and determination to do things, he will find ample inspiration in the numerous problems which are continually arising in his particular field.

Too frequently the "cub engineer" gets off to a bad start because of a lack of interest in shop practice. If he desires to advance to a position of responsibility, he must possess a thorough knowledge of the limitations of practice to apply his theory intelligently. In addition, he must be so well grounded in the fundamental principles that he can diagnose troubles, meet an emergency when it arises, and be able to improve performance and efficiency by an intelligent application of his technical knowledge.

The college graduate, by injecting new ideas and enthusiasm into our industries, is recognized as an important factor in their rapid development. This is true, however, only when he has the ability to mix theory and practice. A responsibility is placed upon industry in the training of these new men and if a spirit of co-operation and understanding between the management and the apprentice can be fostered during this "breaking-in" period, the results are bound to be mutually satisfactory.



The New Gautier Mills at Johnstown

The New Merchant Mills of the Bethlehem Steel Company at
Johnstown Represent the Most Modern in Rolling Mill
Equipment—Complete Safety Protection Provided

By GEORGE A. RICHARDSON*

THE most recent development of note at the Cambria Plant of Bethlehem Steel Company is the completion of four new mills at the Gautier Plant. The Gautier Plant, started many years ago for the purpose of rolling high grade, accurately sized, unusual and special sections such as agricultural machine parts, extremely light angles, tees, zeeks, channels and irregular shapes, has continued to function largely on such work to the present day. Here are located the various Merchant Mills for rolling this wide variety of shapes as well as rounds, squares, flats, automobile rim sections, plates, light structural shapes, and light rails.

The new Gautier layout, which forms part of the general program of modernization and development authorized by Bethlehem in 1922 and 1923, was developed, primarily, for the purpose of increasing the producing capacities of the plant while maintaining the accuracy and excellence of its products. The program involved the replacement of some but not all of the old mills, because many of the units at this plant were already modern and efficient.

The new mills proposed were as follows. A 14 in. mill for rolling structural shapes and light rails; a 13 in. mill for rolling rounds, squares and flats in the following sizes: Rounds 1 in. diameter to 3 in. in diameter; squares 1 in. to 2½ in.; flats up to 4½ in. wide; a 10 in. mill for rolling smaller rounds, flats and squares; and lastly, a 9-in. mill for rolling small special shapes, such as window sash sections, etc.

These four mills were intended to replace the 8 in. No. 1, 8 in. No. 2, 10 in., 12 in. No. 2, 13 in. and 14 in. mills. The 8 in. No. 1 and 8 in. No. 2 mills were installed on a new site under improved conditions.

In considering the building of these four new mills, a number of problems had to be met. To begin with,

they are built west of the older part of the Gautier Plant on a plot, the irregular triangle shape of which made it a problem to get a satisfactory layout. Another problem was the fact that plenty of business was coming through for all of the old mills and it was necessary to plan the new building in such a way that all of the old mills could continue to operate until the new mills could be erected and put into service.

Due to the triangular shape of the piece of ground, the buildings were staggered, each successive one being somewhat shorter. The larger mills were placed in the longer buildings and the smaller mills in the shorter buildings.

Buildings Well Lighted and Ventilated.

The buildings were designed with special reference to good light and ventilation, and 4½ in. brick walls were used. A special feature of the construction is the use of wide monitors, which give exceptionally good light with a minimum amount of glass. Automatically operating ventilators are used for inducing ventilation.

One of the provisions made for insuring good lighting is interesting. Ordinarily a platform is provided for cleaning the windows inside of the monitors, and this tends to cut off a certain amount of light. This drawback has been eliminated by providing a mono-rail trolley with a bos'n's seat in order to facilitate the cleaning of the glass inside when necessary. The sash in the monitor roof is fixed and slopes from top to the bottom so that the panes of glass are practically self-cleaning on the outside. In addition to the monitors there are two rows of windows, set in steel sash, in each side wall, with three rows in each end wall.

There are four new buildings, one for each of the new mills. These were designed by the engineering staff of the Cambria Plant and fabricated in the Bethlehem Shops. In planning the layout, every possible

*Bethlehem Steel Company, Bethlehem, Pa.

provision was made that would facilitate the handling of materials, speed up production, and make for the safety of the workmen. These improvements have been accomplished in various ways, and will be mentioned in due course. Furthermore, the mills were designed with particular reference to maintaining the high quality material for which the Gautier Plant has always been famous. Gautier products have always had a high finish.

Inter-Communication Between Mills.

The problem of providing means of inter-communication between the various new mills is an important one and was solved in such a way that speed and efficiency were obtained without sacrifice of safety. A man-way subterranean tunnel, 6 ft. wide and 7 ft. high, which was extended from the plant entrance transversely to all of the mills with entrance steps to each mill, has proved very satisfactory. A space of about 2 in. intervenes between each end of the stairway treads and side walls of the tunnel. By this construction no corners are provided in which dirt can accumulate. Moreover, a trough between the side walls and the walk-way of the tunnel makes washing the surfaces with a hose a comparatively easy matter.

Adequate means for trucking supplies in and materials out of the mills is an important problem in layouts of this kind. At Gautier a 16 ft. driveway skirts the ends of the new mill buildings and affords such means.

Covered Yards Protect Billets from Weather.

Each mill is served with steel for rolling from a covered billet yard. These billet yards, which are parallel to, and located between, the different mills, afford protection to the billets from the weather, particularly during the winter months, and give the important advantage of cutting down of transportation time. A train of six, or more, cars can be

delivered into the Billet Yard on one shift. Cranes serve the yards or furnaces so that at no time is it necessary for the locomotives to enter the buildings.

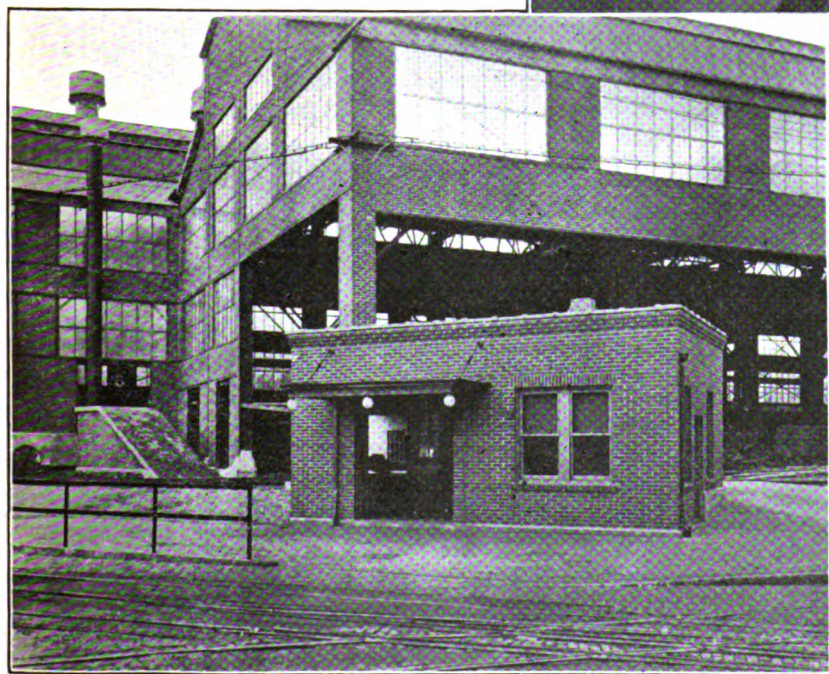
With the exception of the 14-in. mill, each mill delivers into the common shear building, which has a span of 110 ft. The 14-in. mill delivers into the No. 2 and No. 3 warehouses. Three warehouses in parallel with the shear building each have a span of 101 ft., and are located on the site of the old mills. Four cranes take care of the requirements of the shear building and two cranes in each warehouse furnish ample means for shipping materials from the stock piles. Thirteen cranes take care of the needs of the mills and billet yard.

As has already been mentioned, the aim has been to facilitate and simplify the handling of material. As most of the mills are operated on 30-ft. billets it is not necessary to turn the material when taking it from the car and delivering to the furnace.

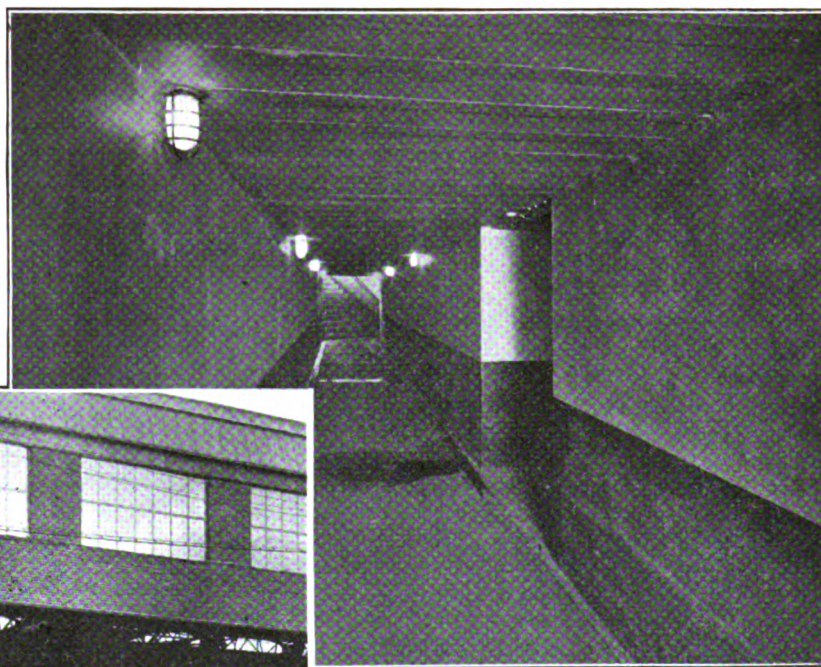
Considerable attention was given to the layout of the plant. The various mill buildings, shear buildings and warehouses; the mills themselves; the tracks which supply and take away material were so arranged as to reduce retrogression to a minimum. A brief description of each mill is given.

Description of the 14-in. Mill.

The 14-in. mill, designed to roll channels, beams,

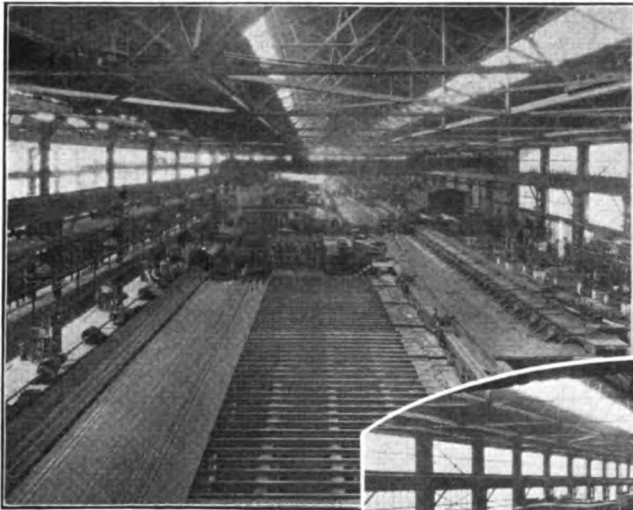


View (foreground) of time office and entrance to man-tunnel to mills.

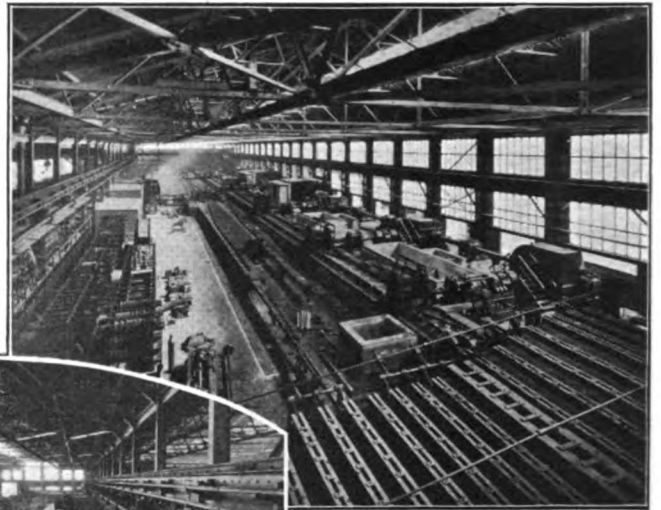


View within man-tunnel looking toward main entrance; aisle to one of the mills on the right.

angles, automobile rim sections, light rails and flats, is housed in a building 600 ft. long and is served by two heating furnaces, the first having a hearth 32 ft. x 56 ft. and the other 17 ft. x 42 ft. The first furnace is used for the usual products of the mill. The second and smaller furnace is used for handling special materials of smaller size. For instance, oftentimes material which is not satisfactory for one purpose is perfectly satisfactory



View of 18-in.-14-in. mill from cooling-bed end.



View of 18-in.-13-in. mill from heating-furnace end.

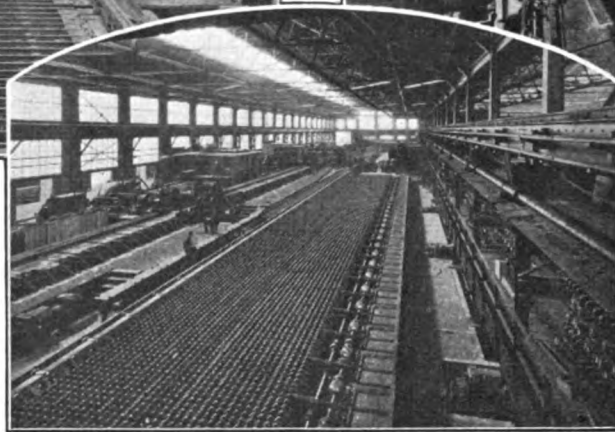
for another. Blooms which do not meet axle requirements will furnish very satisfactory material for light rails, and these blooms would be heated in the smaller furnace.

This mill is provided with ten stands of rolls, five 18-in. roughing stands and five 14-in. finishing stands. The five roughing stands and No. 6, No. 9 and No. 10 finishing stands are operated by a 3000-hp. motor, while No. 7 and No. 8 are driven separately by a 1500-hp. motor. The stands are spaced so that the piece never is in two stands at the same time. Stands No. 1 to No. 5 inclusive, are arranged in tandem, while the remaining five stands are staggered over the mill floor.

On leaving the furnace, the heated billet passes through the first five stands, traveling from the front to the rear of the mill. After leaving the fifth stand, the piece is transferred, by a side transfer, to No. 6 stand, through which the piece passes towards the front of the mill. Similarly, there is a side transfer from stand No. 9 to stand No. 10. The rest of the mill is of the cross-country type throughout. When it can be done advantageously, it is possible to omit stands No. 7 and No. 8, delivering the material direct from No. 6 to No. 9. On the way to the hot beds the rolled pieces, or sections, pass under two motor-driven hot saws, which are installed for the purpose of cutting the pieces into lengths specified. The material then continues on over the roller tables to a hot bed 180 ft. long which is equipped with individual drag-offs. Thence it goes through straightening rolls to a cross transfer bed serving two shears which deliver, in turn, to (a) No. 3 warehouse, (b) No. 2 warehouse.

Description of the 13-in. Mill.

The 13-in. mill is used for rolling rounds, squares, flats and concrete bars in the larger sizes, and is housed in a building 500 ft. long. It is served by one 32 ft. x 60 ft. heating furnace, and has five 18-in. roughing stands and five 13-in. finishing stands. This mill is also of the open type so that at no time is a piece in more than one mill. As the stock leaves the heating furnace, it passes through the first five stands,



View of 18-in.-13-in. mill from cooling-bed end.

which are arranged in tandem. The general arrangement is such that No. 5 and No. 6 stands can be omitted in rolling, as a transfer is provided from No. 4 to No. 7 stand as well as from No. 5 to No. 6 stand. With the exception of the two side trans-

fers mentioned, the mill is of the cross-country type throughout. It has handled at one time as many as eight pieces, either in the actual process of rolling, or passing from one stand to another. On leaving the rolls, the material is delivered to a 180-ft. hot bed, which is of the notch, carry-over type, with thirty notches.

This hot bed is one of the features of the 13-in. mill, and was designed by the company's own Engineering Department, and built in the company's shops. The finished bars coming from the last stand are received by a run-out table equipped with cone type rollers. When the bar is free of the rolls, the axis of the cone type rollers are shifted askew, which transfers the bar onto the cooling bed. The cone rollers are driven by individual motors of fractional horse power.

Hot Bed for 13-in. Mill.

The hot bed, 24 ft. x 180 ft. in size, is divided cross-wise into thirty notches, as already mentioned. The dead load is balanced, and when material is in transit over these beds, at no time is more than one-half of the weight lifted. Shuffle bars are provided at the discharge side of the hot beds and are driven by eccentrics 180 degrees apart. These deliver the stock on to the roller table which conveys it towards the rear of the mill to a shear, where it is cut into commercial lengths, as in standard bar mills.

The motor sizes on the 13-in. mill are the same as on the 14-in. mill; in other words, stands No. 1 to No. 7 are taken care of by a 3000-hp. motor, and No. 9 and No. 10 stands are taken care of by a 1500-hp. motor.

Description of the 10-in. Mill.

The 10-in. mill is a tonnage unit designed to produce rounds, squares, flats and concrete bars, etc. It is a 10-stand mill and served by a 32 ft. x 30 ft. heat-

ing furnace, from which the heated billets are discharged by an electrically driven pusher. Delivery is made directly into four 12-in. roughing stands, of the continuous type, installed in tandem. This roughing train is driven by a 2000-hp. motor. Then delivery is made into four 10-in. finishing stands arranged for looping and from these into two 8-in. stands, which are provided for finishing small sizes. The 10-in. train of finishing stands, which are staggered over the floor, is driven by a 1700-hp. motor, and the two 8-in. stands by one 900-hp. motor. From the finishing stands delivery is made to a flying shear which cuts the sections into convenient bed length, after which they pass onto a notch-type carry-over hot bed 330 ft. long and thence to one shear and gauge as in the 13-in. mill. This mill is also provided with reels for reeling and with a coil conveyor.

The flying shear is of the roller type, with discs set at an angle of 45 degrees to the path of the bar and operated at a speed that will not retard the section. A pivoted guide throws the stock in to the knives and then back again into the regular path of travel. The knives separate on the reversal of the pivoted guide. The hot bed itself is of the notch type, carry-over hot bed.

Description of the 9-in. Mill.

The 9-in. mill is, primarily, a jobbing unit, and is designed to roll miscellaneous shapes. It is served by a 17 ft. x 25 ft. heating furnace, and the heated billets are pushed from the furnace by an electrically driven ejector, delivery being made to four 12-in. roughing stands arranged in two pairs, each in tandem, with a full, open space between the first and second pairs. These rolls are driven by a 1000-hp. motor. From the roughing stands, stock passes to a five stand train made up of two three-high stands and three two-high stands with 9-in. rolls. The first four stands are driven by 1000-hp. motor, while the fifth, or finishing stand, is driven by a 500-hp. motor. Stock is either looped from one stand to another or is run out on

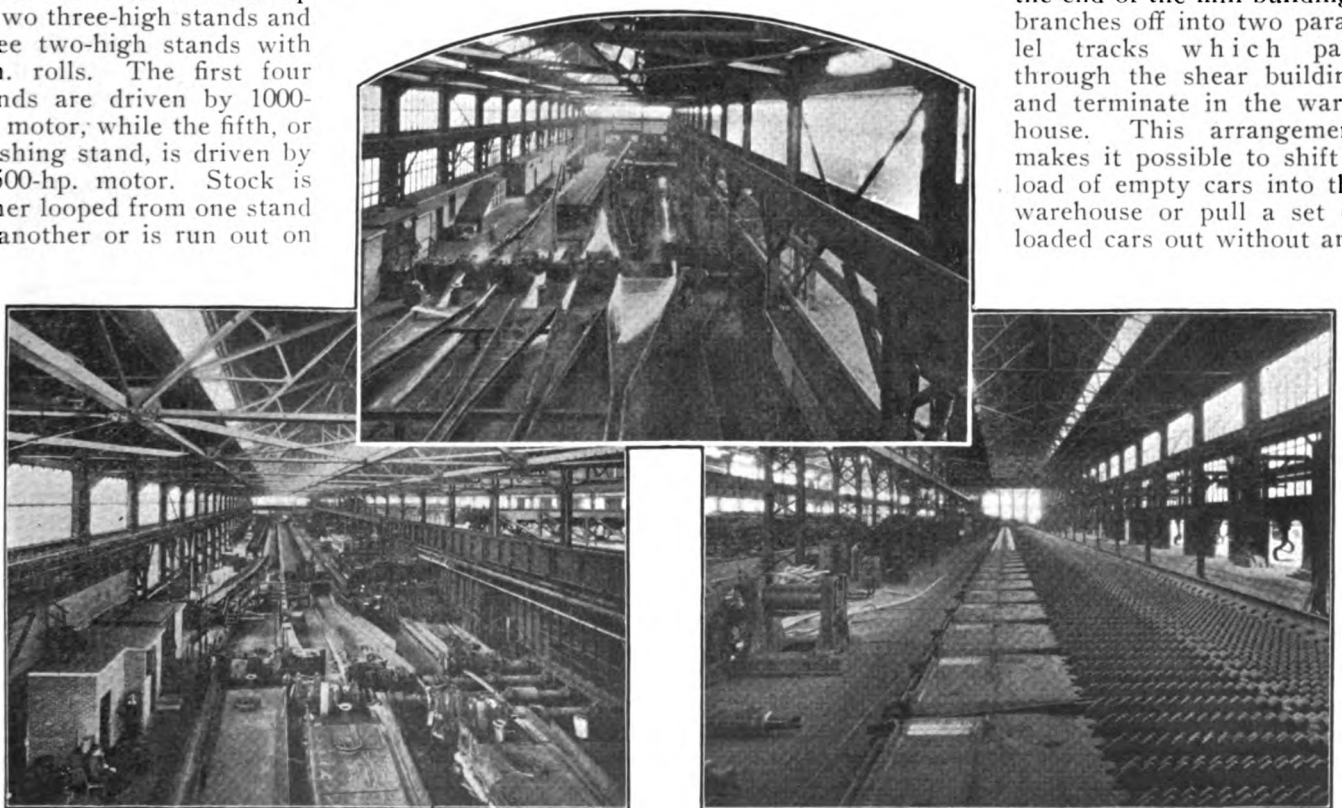
chutes, when it is to be fed into an adjacent stand of rolls. The steel, leaving the last pass, is taken away from the mill on a cone roller run-out table, dropped into a V-notch, from which it is lifted by a carry-over bar and transferred across a flat hot bed 220 ft. long to another roller table which leads to a shear end gauge at the end of the mill, as in the case of other mills.

The Heating Furnaces.

The heating furnaces are equipped for coke oven gas and can use either tar or oil as auxiliary fuel. They are equipped with automatic controls so as to supply proper quantities of air for the gas used and with balanced draft by stack draft control. They have shown unusually good fuel consumption.

A central oil house, equipped with circulating pumps, centrifuges and storage tanks, is arranged to receive all circulating oil and tar required in the new mills. Contaminated circulated oil from all of the mills is pumped to this station to be re-conditioned, and then is returned to the mill when required.

Mention has already been made of the fact that the layout has been planned with a view to facilitating the handling of materials. Several features in regard to the track layout may be mentioned in detail. In the case of the 9-in. and 10-in. mills the track over which the billets are brought into the mills extends into the shear building by one car length. This arrangement provides a means for the immediate disposal of all scrap which accumulates around the shears. Another interesting feature of the track layout has to do with the arrangement of the mill buildings. The 9-in. and 10-in. mills and the 13-in and 14-in. mill buildings are separated by courts. A spur railroad track runs into each of these courts, and near the end of the mill buildings branches off into two parallel tracks which pass through the shear building and terminate in the warehouse. This arrangement makes it possible to shift a load of empty cars into the warehouse or pull a set of loaded cars out without any



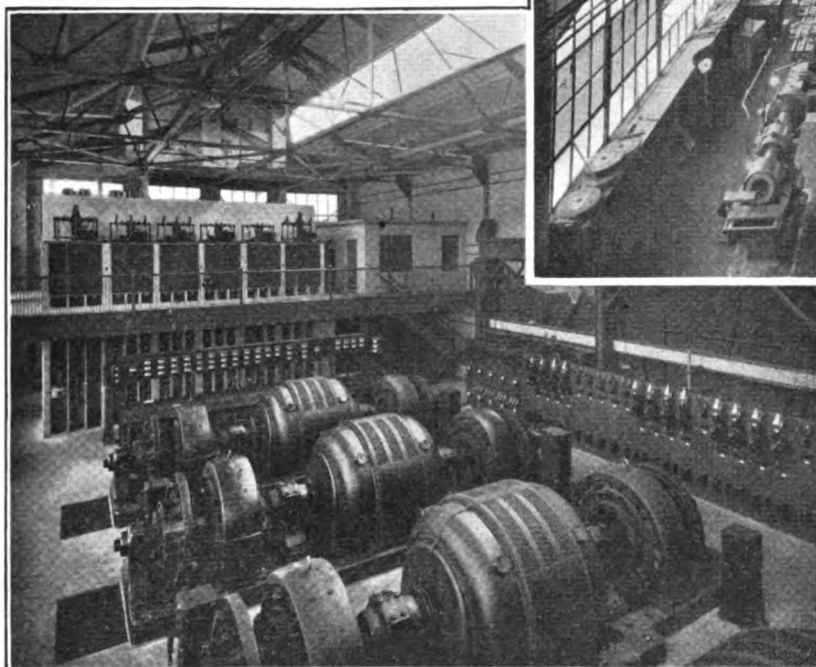
(Above)—View of 9-in. No. 2 mill from the heating-furnace end.
(Left)—View of 10-in. mill. (Right)—View of cooling-bed and coil-conveyor of 10-in. mill.

engine smoke being left either in the warehouse or mill buildings. Subways are provided between the warehouse tracks so that the workmen will not have to climb cars to get from one side to the other.

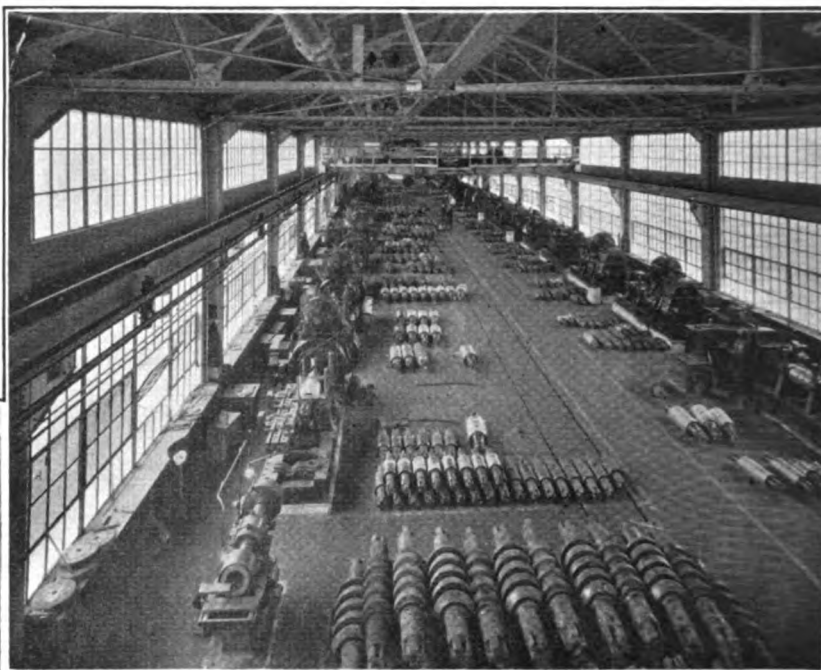
Electrical Equipment.

The arrangement and nature of the electrical equipment in these mills is of particular interest. The automatic stopping and starting control and the new sub-station are among the main features of the electrical layout. All power used in the Gautier mills comes from this sub-station, which is hooked up so that power can be used from any one of three power houses; the power plant at Lower Cambria, the Franklin Power House and the new No. 3 Power House recently

mill, which is driven by two 300-hp. motors, and also the 8-in. No. 2 mill, driven by a 500-hp. motor. In addition, down in the pump house are two air compressors, each driven by a 225-hp. synchronous motor.



View of three motor-generator sets in corner of sub-station.



View of roll turning shop interior.

completed at Franklin Plant. Current comes in at 6600 volts and then splits three ways after going on to the 6600-volt bus. There is a main bus and auxiliary bus.

Oil switches, sufficient to take care of various requirements, are provided, and one extra switch is also provided as a spare. This switch can be used to take the place of any one of the other 6600-volt switches.

All of the old main drives at Gautier were 2200 volts before the sub-station was built. To take care of these, therefore, one oil switch feeds a bank of 4000-kva. transformers which transform the current down to 2200 volts. This 2200-volt current goes onto the 2200-volt bus, from which four feeders go as follows: No. 1 to the 9-in. No. 3 Mill, which is driven by two motors, one of 1000 hp. and one of 800 hp.; No. 2 to the 8-in. No. 3 mill, driven by a 750-hp. and a 500-hp. motor; No. 3 to the 8-in. No. 3 mill sub-station where are located two 500-kw. rotaries; one 600-kva. transformer, which transforms the current down to 220-volt a.c. No. 4 feeder takes care of the 8-in. No. 1

and the main hydraulic pump, which is driven by a 200-hp. motor.

Coming back to the sub-station, another oil switch feeds a bank of transformers of 1200 kva. capacity which drops the current from 6600 volts to 220 volts. These transformers take care of all low tension motors. In another part of the sub-station are five motor generator sets, each of three units. A 2880-hp. synchronous motor, at 6600 volts drives two 1000-kw. generators, delivering 250-volts d.c. The power factor is 80 per cent. These motor generator sets feed all of the new mills, supplying power for the main drives, cranes and auxiliaries.

Motors Ventilated.

A feature of the sub-station layout is the method used in ventilating the motors. The motor generator sets are mounted over a cellar. Air enters this cellar through special shaped louvres, which were rolled at Bethlehem, and act as baffles, diverting the path of the air as it enters. The air passes into the cellar, then into a conduit, thence down, result of this baffling action being that all the heavy dirt is removed from the air. Each motor acts as a fan and sucks up the air through a hole under each generator. The air must be sucked up through this hole, as there is no other place for it to enter in the substation. Special ventilators in the roof provide an outlet for the air.

Still another feature of the sub-station and mill layout is the 48-in. concrete pipe tunnel about 700 ft. long, which is used for the bus bars from which all current used is taken. The main plus and minus bus bars and the third, or stand-by, bus bar are all mounted in this tunnel, on brackets in such a manner

that a clear space is left in the middle for a man to pass through. No one is allowed in the tunnel when the power is on.

The original idea was to build a square tunnel in which a man could walk. The amount of digging required would be the same for either section, but a square tunnel meant the building of special forms and other work, which did not seem warranted, as forms for a circular tunnel were already available. The sections were made and laid and the joints sealed. Push button controls are used on all motors, the whole tendency in this plant being to make the operation as nearly automatic and as simple for the men as possible.

Ample Safety Protection.

The question of providing ample safety has been given the greatest amount of attention, and it is interesting to note just what has been done along this line. A great deal of attention has been given to safety around the mill tables. Cast iron floors cover all of the tables except the table rollers where the stock runs. Similarly, gear guards, spindle guards, etc., have been provided. Wherever possible, stairways are used in preference to ladders, and repair platforms are provided for the cranes. In every way the equipment meets with the strictest requirements of the state laws. Controls are placed so high up that no one can fool with them or get a flash in the face.

Much study was given throughout the whole job to make it possible to clean underneath the tables, a problem which was by no means a small one.

The installation of new mills brings with it the question of providing ample facilities for taking care of the operating needs of the mills themselves, and in the case of the present installation one of the first things necessitated was the construction of a new roll shop, which was erected at the extreme eastern end of the plant. This roll shop is fully equipped with the latest type of roll lathes, grinders, and small tools.

The Turbo-Generator Station.

A new 15,000-kw. turbo-generator station was built at the Franklin Plant and is operated in connection with the new Boiler House at that place, which is equipped with eight 977-hp. boilers. Four of these on 200-lb. pressure take care of the electric turbines, while the other four are provided for general plant use and furnish steam at a pressure of 150 lb. The boilers are stoker-fired and have forced and induced draft, economizers, etc. Coke breeze is used for fuel. This station provides current at 6600 volts, 3 phase, 25 cycle; it is equipped with surface condensers and carries the full complement of auxiliary equipment. The station is connected up

through 6600 and 2200-volt transformers with the No. 1 and No. 2 Power Stations.

It is interesting to note, that the vertical condensate pump used on four of the boilers, the circulating pumps for the spray pond (there are three 12,000 gallon per minute circulating pumps), the air ejectors, extractor pump, etc., are all of Bethlehem design and make.

Among the many things of interest to be seen at the Cambria Plant of the Bethlehem Steel Company at Johnstown is one of the largest bituminous coal mines in the country, which operates through an opening direct into the plant. In this mine there are more than 100 miles of track underground.

Recently No. 5 Furnace at Lower Cambria Plant has been rebuilt and put in operation. This is a very large furnace, having a 20 ft. 6 in. hearth which can be increased to 22 ft. and a 24 ft. bosh which can be increased in the same proportion. A conservative estimate is that the average production of this furnace will be 700 tons per 24 hours.

Blast Furnace Operation Improved.

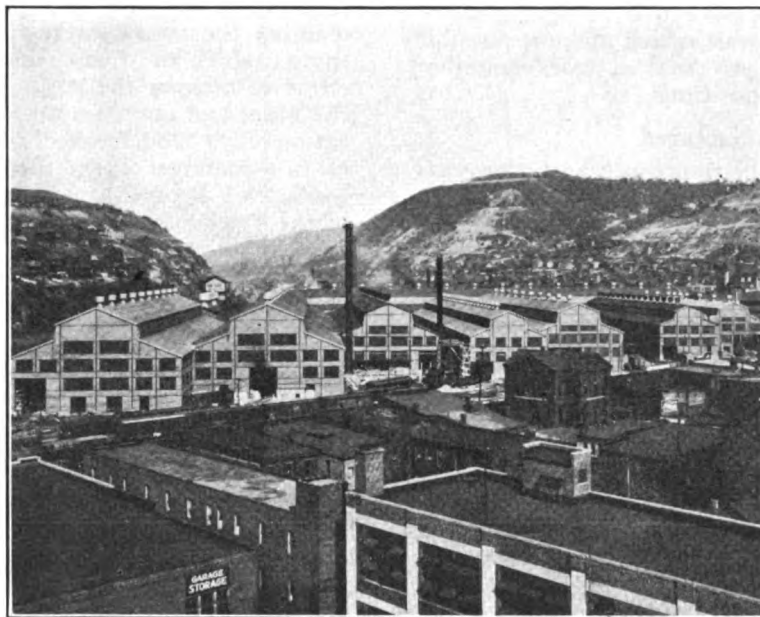
The development of what has been termed the Automatic Blast Furnace at the Cambria Plant is another thing of interest. In other words, improvements have been made so that a rapid approach is being made to the operating of a furnace with the minimum number of men so that any further reduction in man hours per ton of iron produced will be only approached by increasing the size of the furnace. Improvements in every stage of the handling of the materials from the time the ore and other raw materials are brought from mines, etc., have aided in making this possible.

With the blast furnace itself, improvements through electrical operation have made it possible to run the furnace with one man charging, which not only has reduced the amount of labor required, but what is more important, has enabled the responsibility for a number of operations to be taken by one trustworthy man.

Space does not permit going into details of the electrification of this blast furnace equipment and the many improvements involved, including that of automatic stock gauging. This, up to the present time, had to be left to the operator who, if untrustworthy, easily caused trouble.

Those interested can find an illustrated and detailed description which appeared in an article by Mr. Frank

W. Cramer, Assistant to the Electrical Superintendent of the Cambria Plant of the Bethlehem Steel Company, which appeared in the "Iron and Steel Engineer" for June, 1925.



View of buildings for (left to right) the 18-in.-14-in., 10-in. and 9-in. No. 2 mills.

The Car Department.

In the car department of the Cambria Plant at Johnstown, Bethlehem builds all types of steel, composite and wooden freight cars, including box cars, gondolas, hopper and standard gauge tank cars as well as mine and other smaller cars. Another interesting thing about the car shops and one which stands out prominently is the fact that this production is conducted on such a large scale. Here one can see mass production at its best. About a year ago an order was placed by one of the well known railroads for all-steel wood-lined box cars. These cars, when the order was in full production, were being built at the rate of 40 every ten hours. In other words, a completed body was coming off of the erecting tracks every 15 minutes.

Even more striking, possibly, is the actual time required for wooding the car. The wooding consists of putting filler boards in the center sills, laying and wedging up the floor boards, drilling, bolting, cementing the seams, putting up side posts, corner posts, siding, etc. The entire job of wooding the cars was done at the actual rate of 22 minutes per car. The secrets in all of this work have been the sub-division of the job into positions, each man doing his own allotted job; and the extensive use of jigs, gauges, gauge-punching and other aids which make it possible to fabricate the material so that it goes together rapidly at the assembling positions.

Variety of Products Manufactured.

The visitor cannot but be impressed with the great variety of Cambria products. At one end is the wire mill where not only wire, wire fence, barbed wire and similar products are made, but all types and sizes of



View of actuating mechanism underneath cooling bed of 18-in.-13-in. mill.

nails, from the smallest (so small that one nail will weigh only about one-half of 1/1000 of a pound) up to the very largest sizes.

Other divisions produce railroad car axles; structural shapes; rails; miscellaneous bar sections of all conceivable sizes and shapes; coke and coke by-products, such as fuel gas, sulphate of ammonia, benzol, etc., plow discs, harrow teeth, rake teeth, pressed steel teeth for agricultural implements; solid rolled steel wheels; solid rolled and forged steel gear blanks, and similar circular sections; these are just a

hint of the variety of things which are made.

The manufacture of rolled steel wheels is a spectacular sight to the visitor, and he will long remember the special rolling mills and the 12,000 ton presses, gigantic pieces of machinery, which are used in the working and shaping of the blanks from which the wheels are rolled. These presses develop a maximum actual pressure of 12,000 tons.

At the invitation of the Bethlehem Steel Company, the Gautier Division of the Cambria Plant was inspected on Saturday, September 25, by a large group of members and guests of the Association of Iron and Steel Electrical Engineers. Those who took advantage of the opportunity to visit the plant will long remember the many interesting and instructive sights; things which they will feel have been worthwhile the effort of making the trip. Only by making a visit to the plant can one gain an idea of the immense ramifications of a modern steel business, from the handling of raw material down through a variety of finished products. Progress, which has been the life's blood of the steel business, will be found exemplified in all parts of the plant.

To Discuss Steel and Coke

Elaborate arrangements are being made for the one hundred and thirty-fourth general meeting of the American Institute of Mining and Metallurgical Engineers at Pittsburgh, October 5 to 9. The headquarters will be at the Hotel Schenley and technical sessions have been arranged for every day but Thursday, October 7, when a boat trip up the Monongahela River will be taken with visits through the National Tube Works at McKeesport and the plant of the Carnegie Steel Company at Homestead.

On Tuesday, October 5, after registration in the morning, there will be a session devoted to the combustibility of coke in the form of a round table discussion and another session on open-hearth furnaces which will be a continuance of other conferences on this subject which the mining engineers instituted a

year or two ago. In the afternoon of the same day these two sessions will be continued. Wednesday, October 6, will be devoted in the afternoon to a technical session on coal and coke and another one on iron and steel. For Friday morning, October 8, the sessions on coal and coke and on iron and steel will be continued and there will also be one on mine ventilation and another on natural gas. On the afternoon of that day the Bureau of Mines will stage a number of demonstrations, ending with a coal dust explosion in the mine. Saturday, October 9, will be devoted to group trips to points of interest and to industrial plants.

The Standard Steel Specialty Company, Beaver Falls, Pa., has plans under way for the erection of a new addition to its plant, to be one-story, 35 x 95 ft., estimated to cost about \$35,000.

Selection of Coals for Coke Manufacture*

A Discussion of Physical and Chemical Characteristics of Coal
for the Manufacture of Blast Furnace, Foundry, and
Water-Gas Coke in By-Product Ovens

By H. J. ROSE†

PART III

THE coal-mining districts or coal areas of the United States which contain coal are shown in Fig. 28. The shaded areas east of the Mississippi River represent districts which can produce coking coal of reasonable purity (in some places the coal must be washed). Known areas of coking coal west of the Mississippi River, are smaller and more widely dispersed, and the shaded areas indicate, in general, the extent of those coal deposits which are of semi-bituminous or bituminous rank and are said to contain coal having coking properties.

At present there are but three by-product coke plants in the western half of the United States. They are in Colorado, Utah and Washington, and use coal produced in those States respectively.

*A paper presented at the July, 1926, meeting of the American Institute of Mining and Metallurgical Engineers.

†Assistant Chief Chemist, The Koppers Company, Pittsburgh, Pa.

The 41,000,000 tons of coal used in the manufacture of by-product coke in 1922, were produced in the following states:*

TABLE IV Source of Coal Used in By-product Coke Ovens in 1922	
State in which coal was mined:	Net Tons Produced
Pennsylvania	14,243,751
West Virginia	11,489,232
Alabama	5,114,121
Kentucky	7,185,427
Illinois	840,132
Virginia	780,926
Colorado	528,956
Indiana	466,235
Tennessee	37,061
Oklahoma	26,006
Washington	9,390
Arkansas	Small amount
Imported	369,290
Estimated total	41,091,127

*F. G. Tryon, "Coke and By-products in 1922." U. S. Geol. Survey, Min. Resources of the U. S., 1922, Part II.

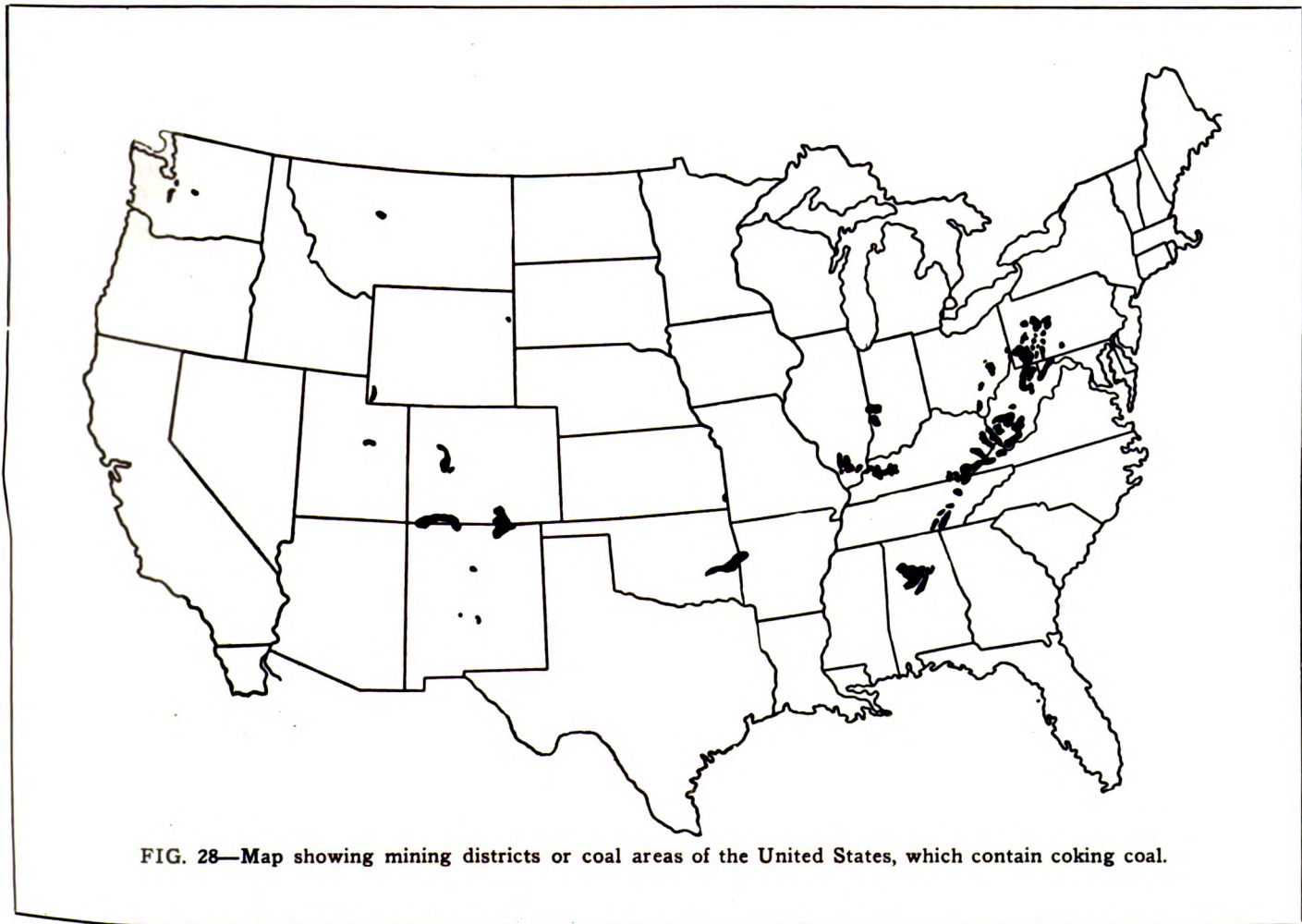


FIG. 28—Map showing mining districts or coal areas of the United States, which contain coking coal.

About 15 to 20 per cent of all the coal used in by-product coke ovens in the United States, and most of the coal so used in Alabama, Colorado, Tennessee and Washington, is washed coal.

Effect of Coal Mixing, Coal Preparation, and Oven Operating Conditions on Coke Quality—The size and strength of coke can be modified and controlled to a very considerable extent by mixing two or more coals together; by varying the preparation and condition of the coal as charged; and by varying oven-operating conditions. A large amount of data on these subjects has been accumulated, but even a brief discussion of their possibilities is hardly practical in this paper.

Coal preparation and condition includes such factors as the degree of pulverization and range of sizes; the moisture content of coal; the quantity and size of pieces of shale, slate, or other mineral matter present; the amount and nature of poorly coking or non-coking material (Figs. 26, 29 and 30); weathering or oxidation of the coal. Most of these variables exert several different and distinct influences, so that the correct application of the various principles which have been evolved, requires considerable skill and practical experience.

The more important oven-operating conditions affecting coke size and strength are oven temperature, degree of under-coking or over-coking, uniformity of oven heating and oven width. The coking time depends on all of these variables.

Chemical and Physical Characteristics Desired in Coke.

Blast-furnace Coke, Ash — The permissible ash content of blast furnace coke in each locality depends upon the purity of the available coals, and will range from about 8 to 16 per cent. The best cokes contain less than 10 per cent of ash, and a strong prejudice exists against coke having more than about 12 per cent, if better coke is available. This means that the coals used should contain not over 9 per cent ash, which is the standard specification of the American Society for Testing Materials* for both gas and coking coals.

In the Pittsburgh district, large quantities of crushed run-of-mine Pittsburgh seam coal having as much as 10 per cent ash, are coked in by-product ovens. When such coal is charged coarsely crushed, a considerable proportion of the shale and slate passes into the nut and breeze coke sizes, and the blast-furnace coke may contain only 12 or 13 per cent ash. If the coal is pulverized, the ash is more uniformly distributed throughout the various coke sizes.

*A. S. T. M. Standard Specifications for Gas and Coking Coals. Serial Designation, D 166-24.

Even after washing, the coking coal available in some localities produces a coke having as high as 16 per cent ash. It must not be forgotten that a blast-furnace plant using a high-ash coke with a very pure or limy ore, may be in just as favorable a position as a plant using a very pure coke with a low-grade ore.

Calculations that have been made from time to time, show that each additional per cent of ash in coking coal reduces its value to the blast-furnace plant about 30 c. per ton on an average, and operators are unquestionably justified in demanding the lowest possible ash in coke. Shale and slate have an injurious effect on coke size and strength, the full extent of which is probably not generally realized.

Sulphur—The A. S. T. M. specifications previously quoted state that coking coal shall be of such composition that the coke produced shall contain not more than 1.3 per cent sulphur, for blast furnace coke. Less than 1 per cent sulphur is preferable, and coke having as much as 1.50 to 1.75 per cent sulphur is not considered acceptable at many furnaces.

The percentage of sulphur eliminated during the coking process depends upon the coals used, but will average around 40 per cent for coals giving a 70 to 75 per cent coke yield. In a general way this means that the percentage of sulphur in coke is from 0.1 to 0.3 less than in the coal from which it was made, but the sulphur content of coke is sometimes as high, or even higher, than the coal used.

It is a fortunate dispensation that many of the coking coals in the far west that are high in ash even after washing, are very low in sulphur.

Phosphorus — The iron used in both the acid open hearth and Bessemer processes must be very low in phosphorus, and coke used in making such iron should preferably contain less than 0.010 per cent of this element. All of the phosphorus in coal passes into the coke, and all of the phosphorus in the materials charged into a blast furnace passes into the iron. A coal containing as much as 0.020 per

cent phosphorus would generally be considered of limited value, as most American blast-furnace cokes are very low in phosphorus.

The phosphorus content of coke used in making basic iron is of little importance, as the basic steel-making processes readily remove this impurity.

Foundry iron is usually required to contain a considerable amount of phosphorus and high-phosphorus ore is commonly used, or phosphatic rock may be added. The phosphorus content of the coke is usually of not much importance.

Size and Strength—Present American practice requires the use of well-sized coke; lumps larger than



FIG. 29—Longitudinal section of box-test coke made from 32 per cent volatile matter and 8.8 per cent ash "splint coal," occurring as a narrow band in a West Virginia high-volatile coking coal. The ultimate analysis of the splint coal is similar to that of the bright coal in the same seam. (See Fig. 30.)

4 in. are usually crushed. Coke breeze (fines smaller than about $\frac{3}{4}$ in.) is detrimental to furnace operation and should always be removed as thoroughly as possible. The nut or domestic size (about $1\frac{1}{4}$ to $\frac{3}{4}$ in.) may be removed if it can be disposed of to advantage, or is often screened out and charged separately into the blast furnace.

The total percentage of blast-furnace coke remaining on a 2-in. square mesh screen is often used as the index of size, and most blast-furnace operators desire the largest possible percentage of coke between the 2-in. and 4-in. sizes.

The only reliable way to determine the size and strength of the coke that can be produced from a given coal or coal mixture, and the yields of furnace, nut and breeze sizes, is to make full-oven coking tests under the desired operating conditions.

Combustibility — There has been an active and extensive discussion in recent years as to the existence and importance of differences in coke combustibility. The subject is too complex for discussion here, but a few comments are required. The term "coke combustibility" has no accepted definition, but probably the best usage is that which refers to the chemical reactivity of coke towards carbon dioxide or oxygen at high temperatures.

Following Brassert's* original discussion of this characteristic of coke, most blast-furnace operators seem to have accepted his ideas at least in part, and some experienced men are thoroughly convinced of the soundness of the theory. The chief evidence presented against this theory consists of the papers of Perrott and Kinney,† and Sherman and Blizard.‡ After a very extended graphic study of the data presented in these papers, the writer stated§ that the conclusions reached were not justified by the data presented. A later paper by one of the same authors|| confirms this opinion, since the later work showed that larger differences did exist in the chemical reactivity of different cokes in fuel beds.

All of the by-product cokes which were tested were found to be far more reactive than any of the beehive cokes tested. This discovery is interesting in view of the now well established fact that by-product cokes give distinctly better efficiencies in the blast furnace

than beehive cokes. In any practical study of coke combustibility, the effect of coke size must not be overlooked.

Density and Structure—Most blast-furnace operators prefer a coke of medium density with fairly large cells and thin or porous cell walls, but there are many variables in furnace operation to confuse individual issues, and a unanimity of opinion on this point can hardly be expected. At some plants a strong prejudice exists against a heavy coke, that is one that gives a high skip weight.

Uniformity—Uniformity of coke is vital to successful and economical furnace operation. Uniform ash and sulphur content are important in maintaining the desired slag composition. Uniformity of coke size is desired, to help prevent the segregation of sizes when the coke is dropped into the top of the furnace. Coke is usually charged by volume instead of by weight, and variation in the apparent specific gravity of dry coke or the size of the coke, may seriously affect the ratio of coke to ore. For these and other reasons it is evident that a coke of very uniform quality may be more desirable than one of better average quality but lacking in uniformity.

Foundry Coke — Foundry coke is used for metal melting, and the chief requisites are purity, large size and good strength, and a minimum reactivity with carbon dioxide gas. As the function of foundry coke is simply to furnish heat by combustion, carbon monoxide gas at the top of the cupola represents wasted energy. This differs from the conditions in the blast furnace, where the complete reduction of carbon dioxide to carbon monoxide in the hearth and bosh is essential to the reduction of iron ore higher in the furnace.

Specification Limits for Chemical Composition — The following specification limits* for the chemical composition of foundry coke have been adopted by the American Society for Testing Materials:

PERCENTAGE IN THE DRIED SAMPLE

Volatile matter	Not over	2.0
Fixed carbon	Not under	86.0
Ash	Not over	12.0
Sulphur	Not over	1.0

The specifications describe car and laboratory sampling, and provide for rejection.

A high-sulphur content is very objectionable and many private specifications require less than 1 per cent of this element. The phosphorus content is usually unimportant. A low-ash content is, of course, desirable. The coke should be thoroughly carbonized.

(Concluded on page 433)

*A. S. T. M. Standard Specifications for Foundry Coke. Special Designation D 17-16.

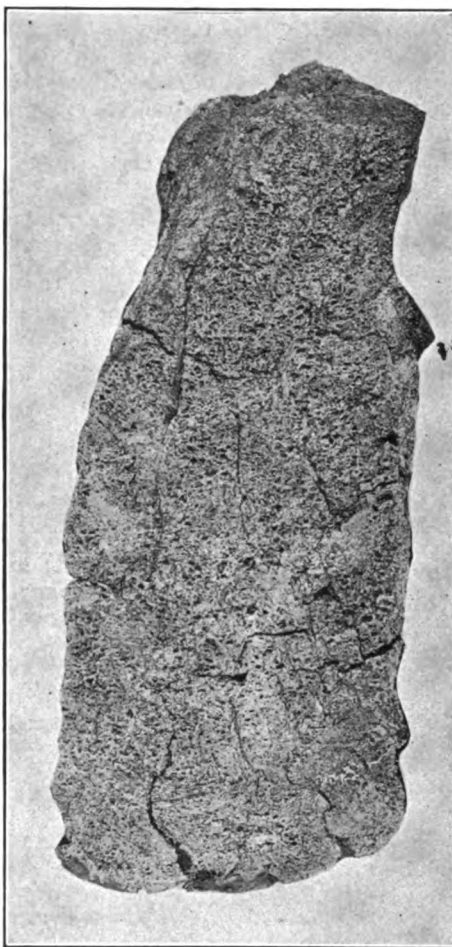


FIG. 30—Longitudinal section of box-test coke made from 36 per cent volatile matter and 2.3 per cent ash "bright coal," from same seam in which splint coal (see Fig. 29) occurred.

*See J. E. Johnson, Jr., "Principles, Operation and Products of the Blast-furnace." (1918), 171-178.

†G. St. J. Perrott and S. P. Kinney, "Combustion of Coke in Blast-furnace Hearth." Trans. (1923), 543-584.

‡R. A. Sherman and J. Blizard, "Combustion of Blast-furnace Cokes in Fuel Beds." Trans. (1923), 526-542.

§H. J. Rose, "Coke Structure and Combustibility." (Unpublished.) Presented before the Eastern States Blast-furnace and Coke Oven Assn., October 5, 1923, Pittsburgh, Pa.

||R. A. Sherman, "Combustibility of Blast-furnace Coke." Iron Age (1925), 1043-45.

Selection of Proper Furnace Insulation

The Purpose of This Article Is to Assist in the Selection of Proper
Furnace Insulation for Various Conditions Which
Are Commonly Found in Practice

By M. H. MAWHINNEY*

A GREAT deal of information is available from various sources on the amount of heat loss through furnace walls that can be prevented by the use of insulation, and the use of insulation has become general in furnace construction, but very little data has been published on the net saving (after the cost has been subtracted) that can be accomplished with various thicknesses of insulation, or how thick to make the insulation for various conditions. It is ordinarily applied with comparatively little thought to the actual economy resulting from its use, and it is the purpose of this article to demonstrate that each case should be considered as a separate problem, and to assist in the selection of the proper insulation for various conditions which are commonly found in practice.

All calculations of this sort must necessarily be based on actual heat losses through walls, and Table I shows the heat lost through walls made up of the common thicknesses of firebrick and insulation expressed in Btu. per square foot per hour. The values in this table are somewhat higher than those obtained with theoretical calculations based on laboratory values of heat conductivity, but they have been found to closely approximate the heat actually lost through average furnace walls.

TABLE I

Heat Losses Through Various Furnace Walls, Btu. per square foot per hour.

Fire-brick In.	Insulation In.	Furnace temperature, Deg. F.						
		1000	1200	1400	1600	1800	2000	2200
4½	0	1050	1250	1480	1860	2130	....	....
	2½	450	510	600	720	850	1005	....
	5	216	300	375	450	530	610	....
	7½	178	215	265	315	362	410	....
	10	150	185	220	260	295	330	....
	12½	140	165	190	220	250	280	....
9	0	550	700	860	1040	1220	1400	....
	2½	310	380	460	560	660	762	....
	5	204	244	269	339	364	429	....
	7½	170	200	232	266	300	334	....
	10	140	170	199	226	253	281	....
	12½	125	150	170	190	212	235	....
13½	0	405	500	590	700	830	975	1120
	2½	230	300	380	455	535	615	705
	5	166	204	244	259	314	349	396
	7½	150	175	200	226	255	285	320
	10	128	150	176	200	228	254	280
18	0	264	365	460	560	660	760	865
	2½	180	239	267	319	367	455	515
	5	149	181	215	247	280	311	349
	10	127	148	170	194	220	240	270

From Table I, the difference between the heat lost with plain and insulated firebrick of various thicknesses can be calculated, this difference representing the saving in heat lost through the wall by the use of insulation. Then for each Btu. saved in radiation

there will be a corresponding fuel saving, the relation between these two figures depending upon the thermal efficiency of the furnace. This latter term in this article is used to designate the relation between the heat in the flue gases and the heat in the fuel burned to produce these flue gases, this relation of course varying with temperature and the fuel burned. The variation of the furnace efficiency with the temperature and the fuel used is shown in Table II, which was calculated on the basis of average values of 10 percent excess air for fuel oil, 20 percent for coal, stoker fired, and 10 per cent for artificial gas.

TABLE II

Furnace Thermal Efficiency, Per cent Variation With Temperature and Fuel

Temperature deg. F.	FUEL			
	Oil	Coal, stoker fired	Artificial Gas	Electricity
1000	78	76	77	100
1200	73	72	72	100
1400	68	66	67	100
1600	63	66	62	100
1800	57	55	56	100
2000	52	48	51	100
2200	46	42	45	100

It is at once apparent that when savings from Table I are divided by the efficiencies of Table II to obtain the saving at the burner or grate, the effect of variation of temperature and fuel on the fuel saving at the burner or grate, will be very marked. It is therefore apparent that the saving in heat lost through the walls must be corrected for this variable efficiency before a cost analysis can be obtained.

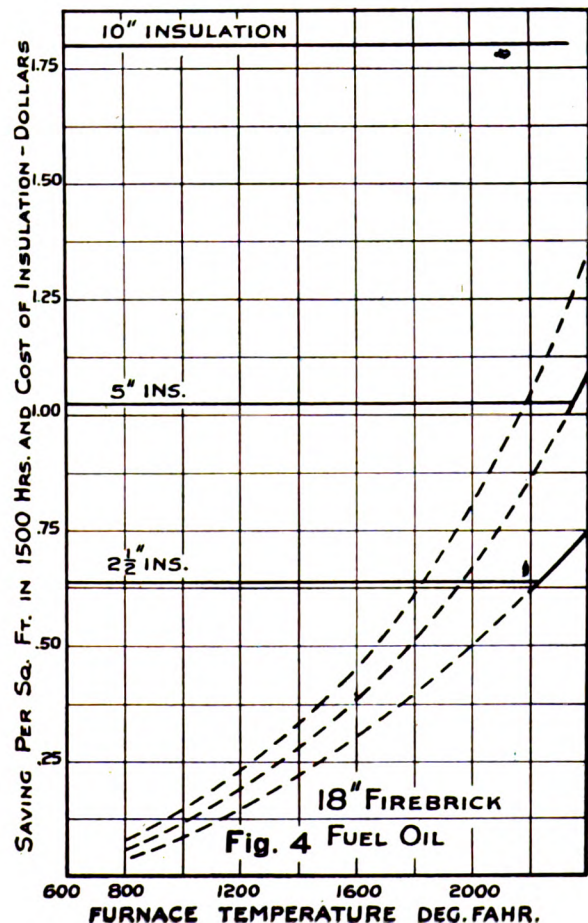
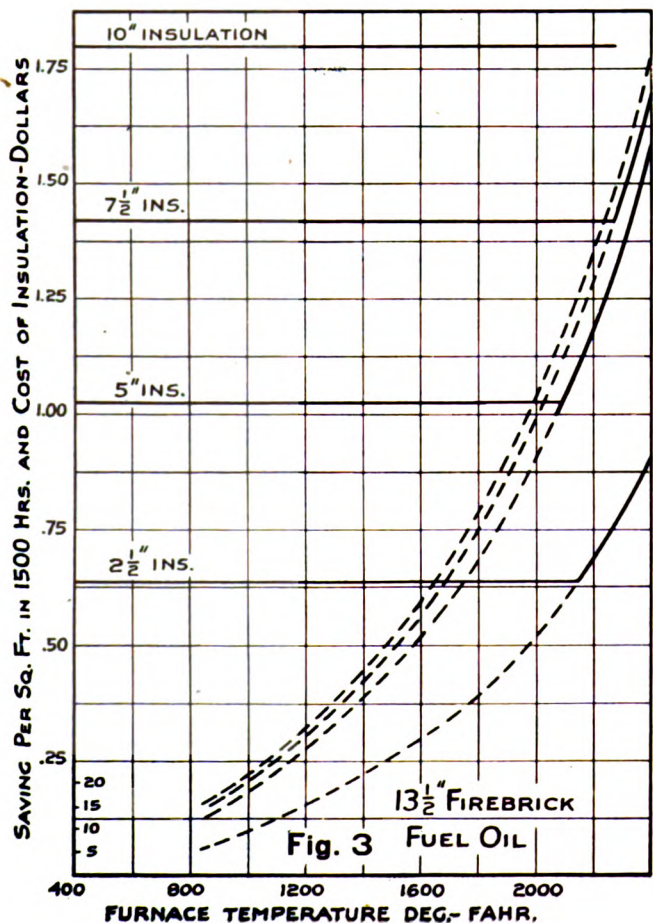
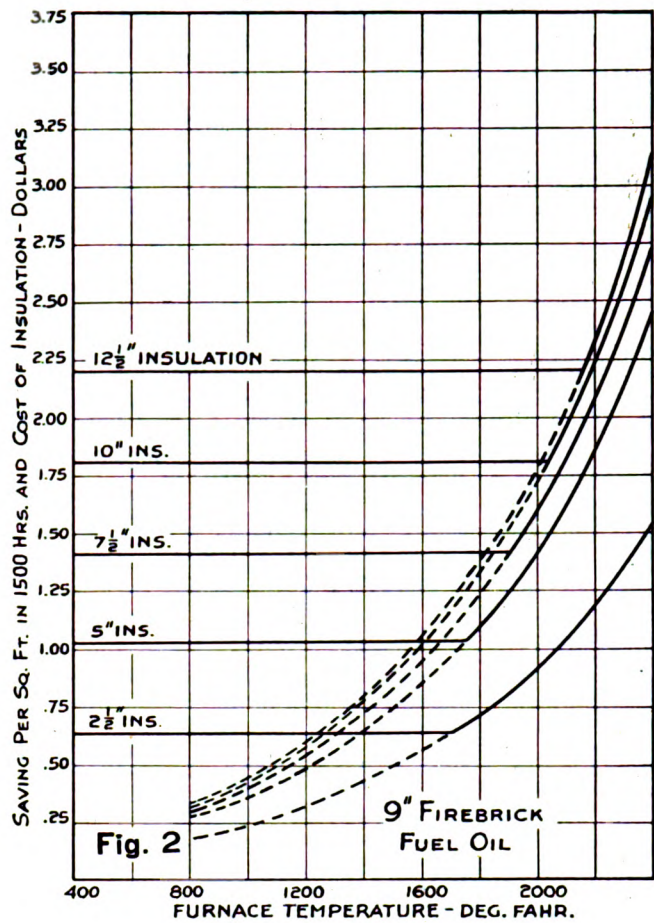
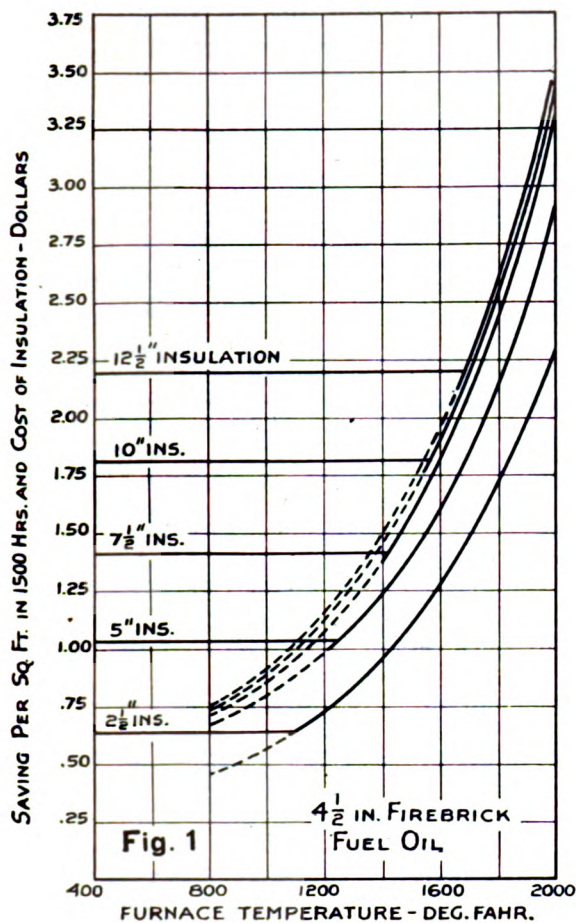
Having determined the true saving in actual fuel consumption, the financial saving is obtained by multiplying by the cost of the fuel. In this article the cost of atomized oil was figured at 7.2 cents per gallon of 144,000 Btu., stoker fired coal at \$5.40 per ton with a heat value of 12,400 Btu. per pound, artificial gas at 61.5 cents per 1000 cubic feet of 560 Btu. per cu. ft., and electricity at 1.5 cents per kw. hour.

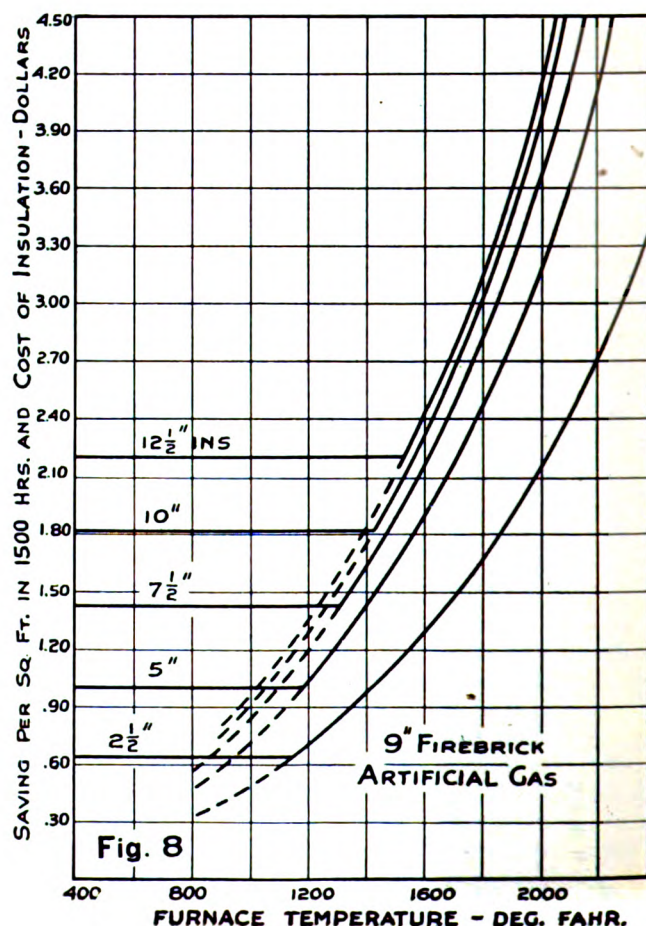
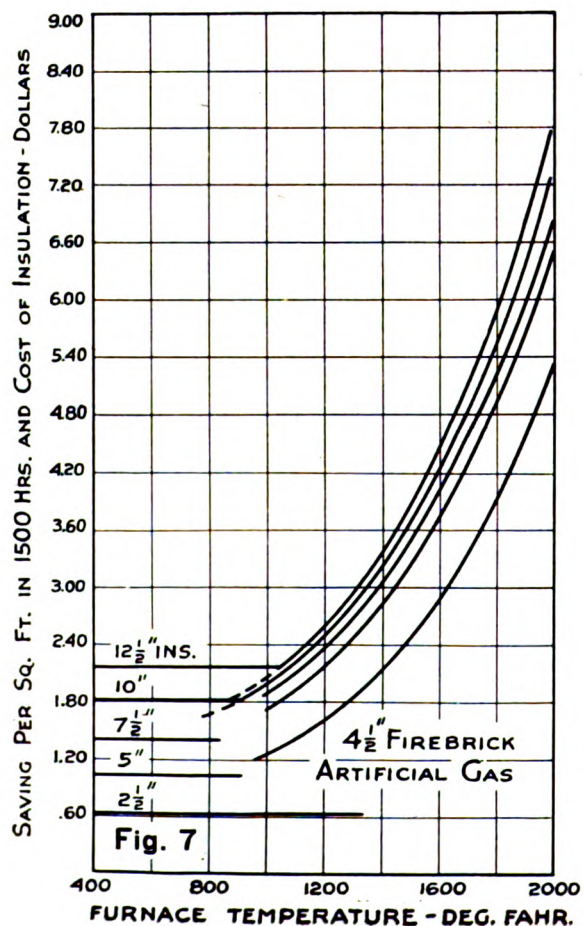
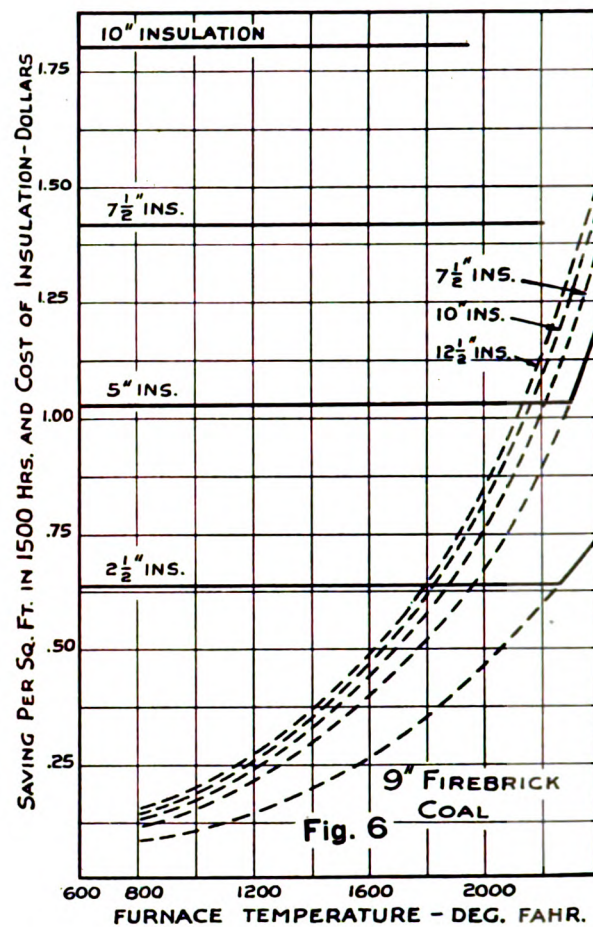
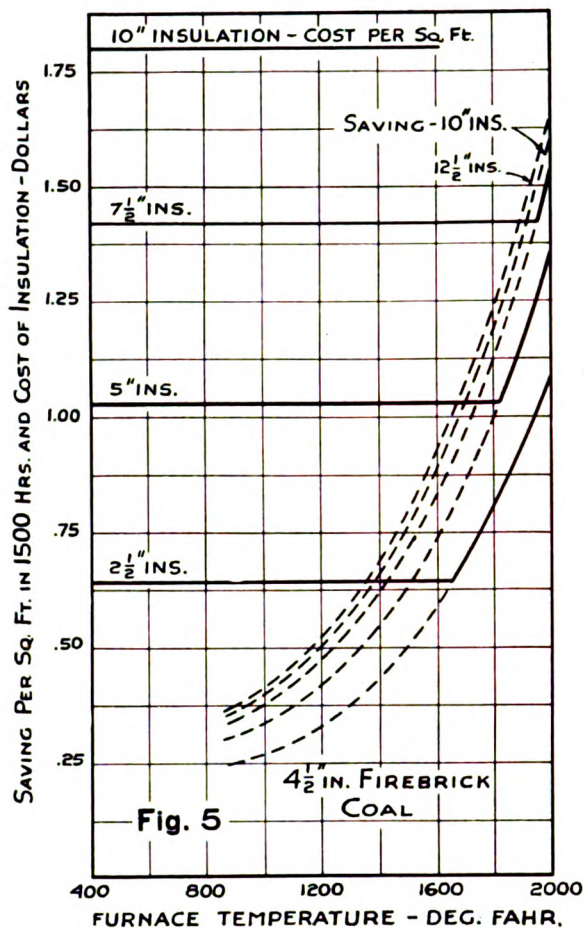
The cost of insulation per square foot, including insulating brick, steel plates necessary, and labor was figured to be 64 cents for 2½ inches of insulation, \$1.03 for 5 inches, \$1.42 for 7½ inches, \$1.81 for 10 inches, and \$2.20 for 12½ inches.

Assuming that it is desired that the insulation pay for itself in a certain period consisting of a definite number of working hours, the saving in fuel per hour can be multiplied by this number of hours as a basis for comparison. The difference between the cost of insulation and the saving in this period is the net saving or loss at the end of this period.

As an example of the above method of calculation, the following are the comparative figures for the net saving with different fuels and five inches of insulation applied to nine inches of firebrick at 1600 deg. F. furnace temperature on the basis of six months time of 1500 working hours.

*Gas Equipment Engineering Company, Philadelphia, Pa.





Heat loss—9-in. firebrick.....	Oil	Coal	Artificial Gas	Electricity
Heat loss with 5-in. insulation.....	1040	1040	1040	1040
Saving—Btu. per sq. ft. per hr.....	339	339	339	339
Thermal efficiency, per cent.....	701	701	701	701
Saving fuel, Btu. per hour.....	63	60	62	100
Saving, dollars in 1500 hours.....	1110	1170	1130	701
Cost insulation, dollars.....	.83	.38	1.86	4.62
Saving or loss, dollars in 1500 hours per sq. ft.....	1.03	1.03	1.03	1.03
	.20 Loss	.65 Loss	.83 Profit	3.59 Profit

The accompanying curves, figures 1 to 12, show the relations between cost of insulation and saving in 1500 hours for various combinations of firebrick and insulation and for various fuels and temperatures, all calculated by the above method. These curves apply only for the assumptions as previously outlined but, since the calculations involve only simple relations, it is easy to revise the curves for either saving or cost on the vertical scale to correspond to any change in fuel cost, desired rate of amortization, or difference in cost of insulation from that which has been used. The intersection of the saving and cost lines for the same amount of insulation gives the temperature at which the insulation will pay for it-

self in 1500 hours with the values as selected. It will be seen from a study of these curves that up to a certain amount, insulation effects a very considerable saving, but that above this amount the saving per inch of additional insulation becomes gradually smaller. The actual saving or loss for any condition of temperature, fuel, or brick thickness can be obtained by comparing the values of insulation cost and saving given on these curves. The first step in the selection of insulation is a determination of the time limit that is to be allowed for the insulation to pay for itself. Since the saving from insulation after it has paid for itself is clear profit, and because the usual life of furnace and insu-

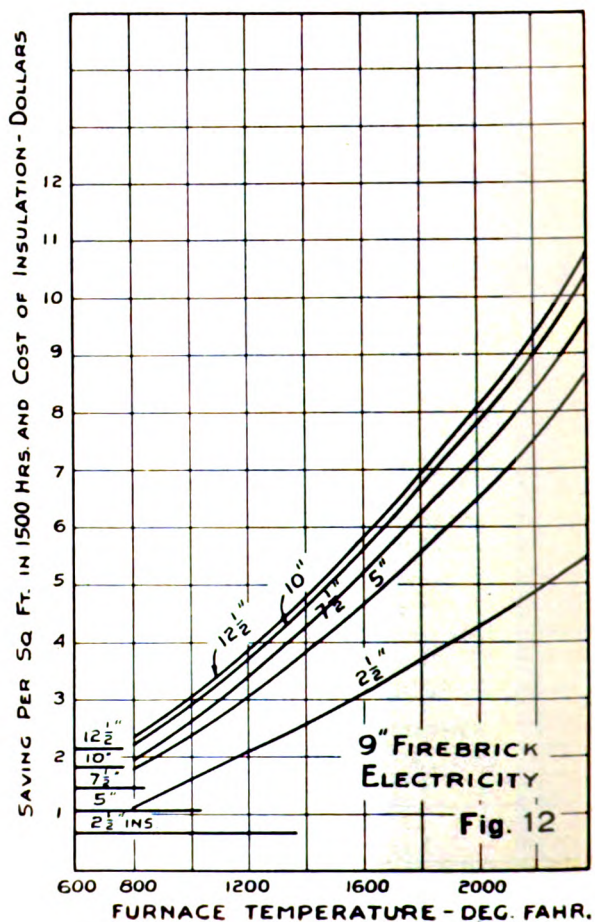
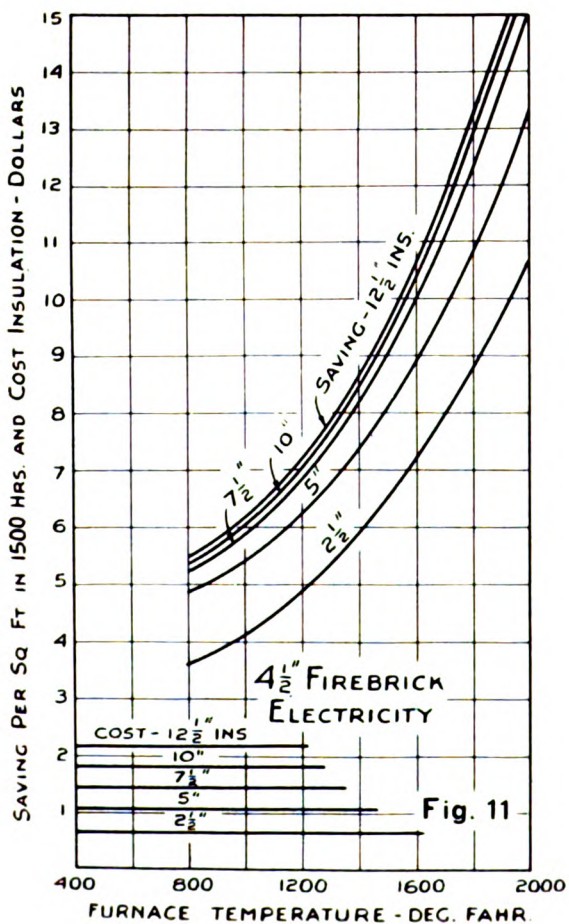
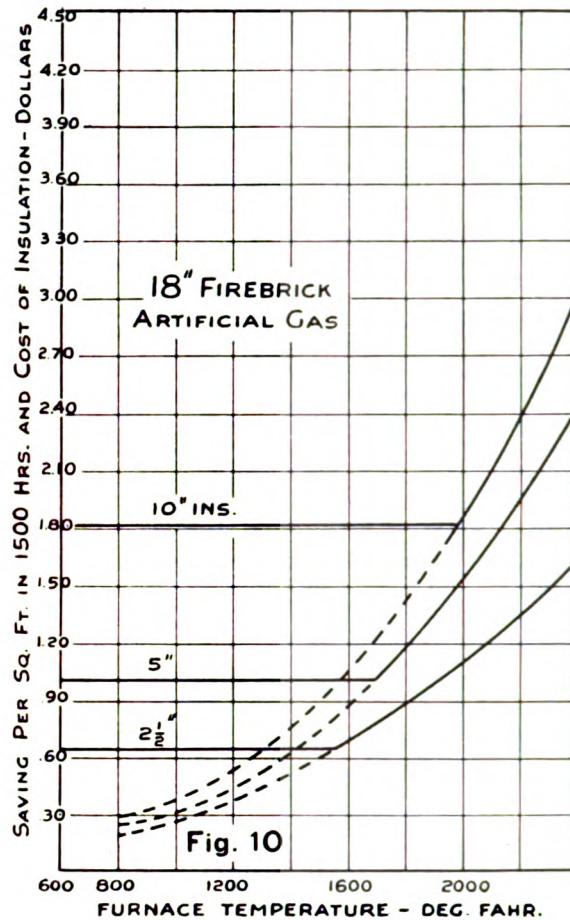
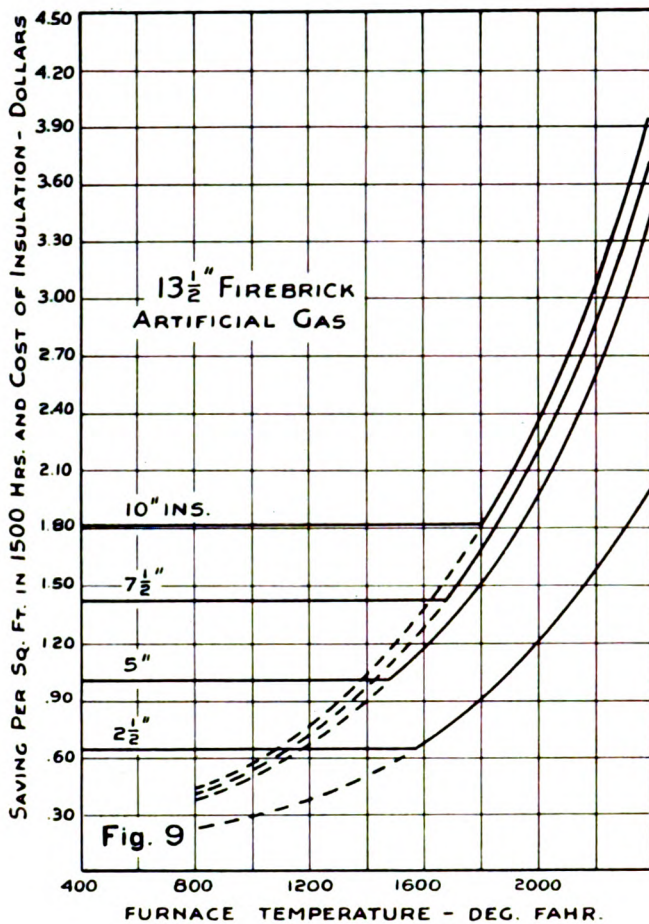
TABLE III
Time in Months Required for Insulation to Pay for Itself for Various Fuels, Temperatures, and Thickness of Firebrick and Insulation

Fire-brick, In.	Insulation In.	Furnace Temperature, Deg. F.					
		1000	1200	1400	1600	1800	2000
FUEL, OIL.							
4½	2½	6.74	5.26	4.00	3.03	2.20	
	5	7.73	6.30	5.06	3.87	2.90	
	7½	10.00	7.95	6.21	4.73	3.55	
	10	12.50	9.87	7.49	5.71	4.35	
	12½	14.86	11.50	8.85	6.76	5.18	
9	2½	16.70	12.00	8.93	7.24	5.48	4.26
	5	17.69	12.90	9.50	7.28	5.63	4.42
	7½	21.30	15.80	11.85	8.97	6.92	5.40
	10	25.90	19.10	14.10	10.65	8.23	6.17
	12½	30.00	22.00	16.50	12.60	9.60	7.54
13½	2½	38.40	29.50	17.40	12.80	9.85	7.51
	5	34.4	22.9	15.85	12.10	9.09	6.86
COAL.							
4½	2½	14.80	11.60	8.93	6.51	4.80	
	5	18.20	15.10	11.25	8.37	6.19	
	7½	23.00	18.10	13.75	10.40	7.68	
9	2½	38.40	27.50	19.20	14.78	11.00	8.54
	5	41.30	29.50	21.35	15.90	12.10	9.50
13½	2½	76.90	54.90	42.60	29.60	22.60	16.70
ARTIFICIAL GAS							
4½	2½	3.07	2.40	1.91	1.37	1.00	
	5	3.54	2.94	2.25	1.67	1.27	
	7½	4.53	3.59	2.66	2.13	1.64	
	10	5.52	4.38	3.37	2.56	1.97	
12½	6.59	5.19	3.98	3.01	2.29		

Fire-brick, In.	Insulation In.	Furnace Temperature, Deg. F.					
		1000	1200	1400	1600	1800	2000
ELECTRICITY							
9	2½	7.25	5.33	3.96	3.00	2.36	1.83
	5	8.60	5.89	4.30	3.24	2.50	1.98
	7½	10.50	7.16	5.23	4.00	3.10	2.39
	10	12.20	8.50	6.20	4.78	3.70	2.83
	12½	14.05	10.10	7.30	5.60	4.32	3.30
13½	2½	13.70	10.10	7.68	5.82	4.31	3.22
	5	12.62	9.37	7.03	5.33	4.04	3.04
	7½	16.40	12.35	9.06	6.66	5.13	3.88
	10	24.90	18.30	13.35	8.25	6.20	4.68
18	2½	15.40	10.70	7.70	5.83	4.27	3.50
	5	19.90	14.05	9.95	7.10	5.32	4.11
	10	27.85	19.75	14.50	10.50	7.75	6.00
4½	2½	.94	.80	.67	.53	.44	
	5	1.14	1.00	.85	.70	.57	
	7½	1.44	1.25	1.04	.86	.70	
	10	1.81	1.55	1.30	1.07	.86	
	12½	2.16	1.86	1.54	1.27	1.02	
9	2½	2.40	1.83	1.48	1.22	1.04	
	5	2.69	2.06	1.63	1.34	1.12	
	7½	3.27	2.50	2.03	1.67	1.40	
	10	3.82	2.94	2.36	1.94	1.64	
	12½	4.40	3.47	2.81	2.28	1.91	

lation is about five years, almost any reasonable amount of insulation will show a profit before the furnace is worn out, but most companies adhere to a definite policy of time allowance in which equipment must pay for itself regardless of probable life. This definite time is calculated on the basis of the

lation is about five years, almost any reasonable amount of insulation will show a profit before the furnace is worn out, but most companies adhere to a definite policy of time allowance in which equipment must pay for itself regardless of probable life. This definite time is selected due to rapid changes in



equipment and methods, and the consequent possibility that some change will be made before a satisfactory profit has been realized if the time allowance is too great. This allowance varies from six months to two years, depending on the nature of the operation involved and the financial policy of the company.

After this time limit has been determined, if it is greater than six months as used in the curves, they can be revised by increasing the saving in proportion to the increase in the number of hours allowed over the 1500 hours figured. The saving or loss in money for any case can then be calculated as outlined above. Where it is not necessary to know the actual saving, but simply to determine the correct quantity of insulation to use, Table III can be used if the original assumptions of cost of insulation and fuel apply. It shows for all cases the number of months which are required for insulation to pay for itself, and if the time allowance for amortization is known, the correct amount of insulation can be selected directly from the table for any condition of temperature, fuel, and brick thickness. The lines given in the table mark the desirable amounts of insulation for a time allowance of six months of 1500 hours.

As an example of the use of these tables to select the most desirable amount of insulation, suppose that it is desired to find the proper amount of insulation for an oil fired furnace operating at 1600 deg. F. temperature and having nine inch firebrick walls. If the rule of the company or circumstances make it desirable that the insulation pay for itself in six months of 1500 working hours, reference to the table shows that less than $2\frac{1}{2}$ inches of insulation should be used, but if seven or eight months is satisfactory, five inches can be used, and even $12\frac{1}{2}$ inches will pay for itself in one year in this case.

In conclusion, it is apparent from a study of the accompanying charts and curves that each case should be considered as a separate problem, because the correct insulation for one temperature and fuel is by no means correct for other conditions. But a consideration of financial management is also involved in every case, and a time limit within which the insulation must pay for itself in saving must be set from experience in the particular business for which the furnace is intended, probable time that the equipment will be operated, and financial policy. Then, for the existing fuel and temperature conditions the insulation can be so selected as to pay for itself in this time.

Three-Wire Direct-Current Generators*

Over-speed Protection—Compensator Does Not Need Protection
—Locations of Devices and Instruments in Circuits—Two
Types of Control Equipment—Operation Analyses

By WAYMAN A. HOLLAND†

THREE-WIRE direct-current generators may be engine-driven or motor-driven. When motor-driven they are usually equipped with a speed-limit device connected to trip the d.c. breaker and thus prevent over-speeding due to a weakening of the generator field or to a loss of the motor supply. The exception in which a speed-limit device is not needed with a motor-driven set is where the generator is not intended to operate in parallel with other generators.

The three-wire feature is obtained by the introduction of a compensator, usually single-phase, connected across opposite points in the armature winding. The neutral is derived from the mid-point of this compensator winding. The compensator may be installed in the machine itself as a revolving unit with the neutral brought out to a single collector ring attached to the commutator shell, or it may be installed as a separate unit for floor mounting, in which case two collector rings are necessary for the compensator. The neutral is then at stationary connection. For some machines having a rating above 500 kw., poly-phase compensators might be used.

If desired, an over-current relay can be installed in the neutral lead to trip the main breakers of the machine should the neutral current reach a value that is excessive for the compensator coils. This is a

remote contingency in a well-designed and well-attended plant, however, and usually no protection is provided for these coils.

As a rule, compensators are at present designed to take care of 10 to 25 per cent current unbalancing, the voltage difference between the two sides being held within 5 volts, or 2 per cent of the total voltage. Higher percentages of unbalancing may be taken care of by special compensator design.

Since three-wire generators are usually compound-wound, only this type of machine will be considered.

When arranging for the protection of such generators, care must be taken that the current actuating the protective devices and the instruments is the armature current and not the line current; i.e., the circuit breakers and ammeters must be connected between the armature and the equalizer. If connected on the line side of the equalizer tap, the current actuating the breaker (and the instruments) will be the algebraic sum of the equalizing current and the armature current, thus rendering impossible the obtaining of a correct check on the division of load among several machines as well as interfering with the proper protection of the machines against overload in the armature.

In order to obtain adequate compounding and equalizing it is necessary to divide the series field into two parts, one-half connected in the positive lead, and the other half in the negative. This arrangement requires a second equalizer.

The use of twice as many circuit breakers and equalizers introduces complications in the cable runs

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between the machine and switchboard, making necessary six main leads where in a two-wire machine but two main leads and one equalizer lead would be used. The six leads are additional to the neutral lead.

The fundamental standard connections of two complete equipments are shown in Fig. 1, wherein each generator involves the use of a double-pole, two-coil, overload circuit breaker, two main and equalizer

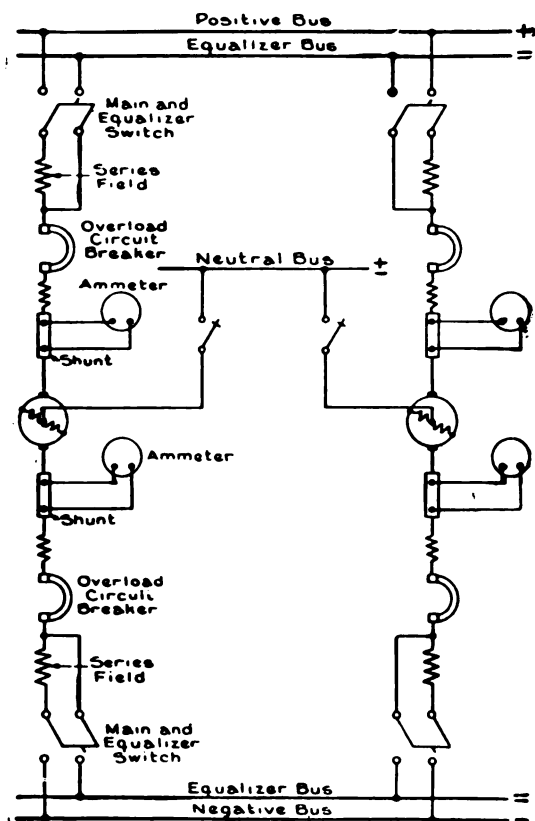


FIG. 1—Diagram of the fundamental standard connections of equipment for two, three-wire, direct current generators in parallel.

switches, two ammeters, and a neutral switch. To connect a generator to the buses (with other generators already connected) the following is the correct procedure:

- 1—Adjust the shunt field until the voltage of the incoming machine is the same as the bus voltage.
- 2—Close the main and equalizer switches (this connects the series fields of the incoming machine in parallel with the fields of the machines already connected).
- 3—It may now be necessary to readjust the voltage of the incoming machine due to the influence of the now-connected series field.
- 4—Close the two main breakers, one after the other.
- 5—Close the neutral switch.
- 6—Adjust the load by regulating the shunt field.

To disconnect the generator from the buses, the shunt field should be regulated to give zero load, the breakers opened and then the lever switches (including the neutral switch).

In some discussions of three-wire generator operation the statement has been made that the equalizer

connections and those of the armature to the bus should be made, or disconnected, simultaneously to avoid voltage disturbance at the time of switching. This switching operation can be accomplished by the use of a four-pole, three-handle breaker having all handles trip-free and 10 studs to be connected as illustrated in Fig. 2. The four poles open simultaneously, the two central (equalizer) poles closing with one handle, and the two outer poles closing separately. With this equipment no line lever switches are required, and even the neutral switch may be omitted if desired. The correct procedure for connecting such a generator to the buses is as follows:

- 1—Adjust the shunt field until the voltage is the same as the bus voltage.
- 2—Close the equalizer poles.
- 3—It may then be necessary to readjust the voltage.
- 4—Close the line poles.
- 5—Close the neutral switch (if one is installed).
- 6—Adjust the load.

To disconnect the generator from the buses the same procedure should be followed as was described for the fundamental connections shown in Fig. 1, except that with this latter arrangement the tripping of any pole of the breaker will trip all simultaneously.

As to the merits of closing and of disconnecting the equalizers simultaneously with the line, it will now be shown that it is more advantageous to close the equalizers in advance of the armature connections to the bus than to do this switching simultaneously.

Fig. 3 shows a typical voltage-load curve of a compound-wound generator. Because of the "hump" in the curve, the compounding is "flat" only at the full-load (100 per cent) value, and with any variation of load there is a variation of voltage. Now when the equalizers are closed and place the series fields in parallel with the fields of the machines already operat-

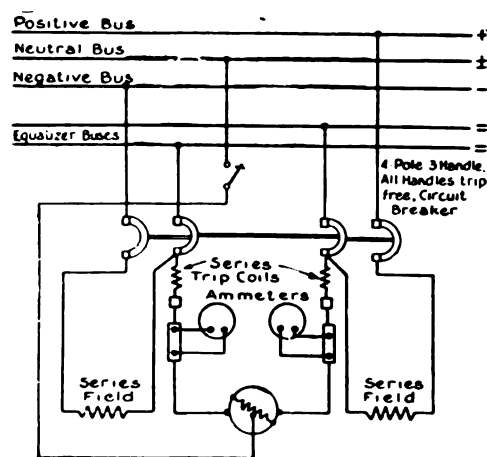


FIG. 2—Wiring diagram of a three-wire generator which is connected to the buses and equalizers through a four-pole, three-handle (all trip free) circuit breaker.

ing, there will be a dip in the line voltage due to the lesser series-field current because of the newly introduced path. This dip need not be of serious magnitude. Moreover, it is not eliminated by closing the armature breakers simultaneously with the equalizers of a properly manipulated machine, for there will be no armature current when the armature breaker is closed.

When placing a machine on the line it should be recalled that it is very difficult to maintain the incoming voltage exactly equal to the bus voltage, and therefore, to assure that the machine voltage will not be too low most operators like to set it a little above the bus voltage. If, under such conditions, the equalizer circuit has not been previously closed and conditions allowed to become stabilized, there is a chance that the instant of closing the armature circuit there will be a "hogging" of the load by the incoming machine and this will have a much more disturbing effect on the system voltage than the connecting of the series field alone.

For this reason provision should always be made for closing the equalizers in advance of the armature. It is obvious that under no circumstances should the armature be closed in advance of the equalizers.

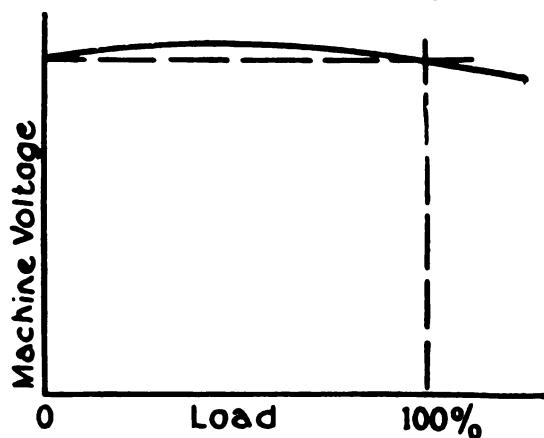


FIG. 3—Typical voltage-load curve of a flat-compound generator.

When taking a machine off the buses it will be entirely immaterial whether the equalizer is disconnected simultaneously or afterward, so far as the effect on the voltage is concerned. The armature current will be adjusted to zero, so the opening of the armature circuit will not in any way affect the line conditions. The equalizer can be opened at the same time or later, and any voltage disturbance due to this will be the same as before.

An objection to the use of a circuit breaker in the equalizer connection, besides the increased cost, is that this device by reason of its construction has a higher resistance than a lever switch.

It will be noted that the same number of cables is required for either of the two schemes. For generators of 300 kw. and larger, the use of solenoid-operated breakers located close to the machines will reduce the length of the necessary cables.

Selection of Coals for Coke Manufacture

(Continued from page 425)

By-product foundry coke is usually screened over a 3-in. grizzly. Foundrymen almost universally require a large, hard, strong coke and are accustomed to pay a premium in order to obtain coke which meets their standards of size, strength and purity. In order to obtain a good yield of foundry-size coke, one or more of the following procedures may be resorted to:

1—A large percentage (30 per cent or more) of low-volatile coal may be mixed with a selected high-volatile coal. The proper coals and proportions are determined by experiment. The volatile matter of the

coal mixture is usually 25 to 28 per cent. This is a common method for producing foundry coke.

2—A medium volatile coal or mixture of such coals may be used. This is satisfactory where the proper coals can be obtained.

3—By the use of low temperatures and a long coking time, the size of the coke pieces can be much increased.

Domestic Coke—The most important characteristics that depend on the coal used, are the ash content, fusing temperature of ash, and density of the coke.

The ash content of cokes sold for domestic use varies widely from plant to plant, depending upon the kinds of coal which are available, and the purposes for which the coke plants are being operated. In some cases coals containing less than 6 per cent ash are regularly used, and the 8 or 9 per cent ash coke which is produced is suitable in this respect for the most strongly competitive markets. Domestic cokes containing 10 to 15 per cent ash may be classed in most localities as good to fair, respectively. Nut-size coke of still higher content is produced by some plants, but it is not made with the requirements of the domestic trade in view, and is usually sold at a considerably lower price than first quality domestic coke.

A fusing temperature of 2500 deg. F. or over is desirable for ash, and the higher this temperature the better. However, the permissible fusing temperature depends to a considerable extent upon the amount of ash in the coke, the coke size and the nature of the domestic use to which it will be put. Certain low-ash cokes having an ash fusing temperature of 2300 deg. to 2400 deg. F. have acquired an excellent reputation. The American Society for Testing Materials standard specifications for gas and coking coals (previously mentioned) give 2200 deg. F. as the minimum, but this is unquestionably a low limit.

Since the cubic foot weight of coke is lower than that of coal, a dense coke is usually desired in order that a sufficient weight can be charged into domestic appliances at each firing.

Water-gas Coke—The most serious operating problems connected with water-gas manufacture are due to the presence of clinker and its removal. The amount of ash present in coke has an important bearing on the frequency and cost of clinker removal, and the output of water gas. It is hard to over estimate the advantages of low-ash coke, both from the standpoint of ease of operation and cost of gas made. Coals containing 6 per cent or less ash are indicated for the manufacture of high-grade water-gas coke.

The ash fusing temperature is, of course, important, and in general should range from 2400 deg. to 2500 deg. F. with 2300 deg. F. as a lower limit. Many operators would not put any upper limit on the ash fusing temperature, but some experienced men state that an ash of too high a fusing temperature causes troublesome wall clinker. The ash fusing temperature that is best for a particular plant will depend somewhat upon operating conditions.

A low-sulphur content is desirable, as part of the sulphur passes into water gas as hydrogen sulphide.

Water-gas coke preferably consists of lumps ranging from 2 to 4 in., but much of the coke used for this purpose has had only the fines removed. Breeze is objectionable, and the coke should be strong enough to permit handling without excessive breakage. Uniformity in the size of coke as charged is greatly to be desired.

Lighting in the Metal Working Industries*

Adequate Illumination Is Essential to the Promotion of Safety
and Industrial Efficiency—Artificial Lighting in
Steel Mills and Foundries Discussed

By A. L. POWELL and W. H. RADEMACHER

ADEQUATE and properly applied artificial illumination is an indispensable adjunct to successful plant operation. Numerous investigations and tests have proved conclusively that artificial lighting may be a means to the promotion of safety, increased production, reduced spoilage, better sanitation, and a high morale among employees. In other words, good lighting and industrial efficiency are inseparable.

Contrary to the view held by some, artificial light is quite necessary regardless of whether work is carried on at night or during the daytime. In the former case the necessity is obvious—in the latter it may be pointed out that during the daytime working hours throughout the entire year there is an average of approximately two hours per day during which artificial illumination must be used because of failing

sible good vision in any location or position, and, where overhanging machine construction does not prevent, is the ideal method of factory lighting.

Group or Localized General Lighting—Such a system consists of light sources mounted overhead but located with respect to machine or benches in order to provide an increased intensity or preferred direction of light for major working positions. Where work is confined to certain sections of a plant or where overhanging machine construction exists, this scheme of lighting is to be preferred.

Local Lighting—Such a system consists of a light source for each working position, mounted close to the work so that illumination is concentrated over a small area, and provides no general lighting. Where extremely high intensities of light are required, local lighting in conjunction with general illumination is desirable. Wherever one of the other forms of lighting previously described is applicable, it should always be used in preference to local lighting. The major objections to local illumination under any condition other than that described above are as follows:

1—High installation cost—due to the large number of outlets, lamps, reflectors, and wiring material required.

2—High maintenance cost—due to the large number of outlets which must be serviced, high breakage through handling of lamps by operators, theft due to the accessibility of lamps, and wiring troubles caused by manipulation of lamps, reflectors, and connections on the part of the operators.

3—Greater eye fatigue, accident hazard, and poorer appearance of room, combined with less cleanliness when no general lighting is used, due to spotty lighting and relatively dark areas above the light source. The light sources, being under the control of the operator, are frequently tied in a position which suits the fancy of one and creates a condition of glare objectionable to another.

General Considerations.

It has been said that light may be produced by lamps without reflectors, but not by reflectors without lamps. This statement is true, but lamps without reflectors not only waste power but also are a cause of ineffective lighting due to glare. The purposes of reflectors are two-fold—to distribute efficiently the light which is created by the lamp on the working plane, and to protect the eyes of the workmen from the brightness of the lamp filament. Reflectors may also be designed so as to lend an element of protection to the lamp, as in the case of metal guards and vapor-proof enclosing globes.

In reflecting equipment, as in practically all other devices used in the metal working industries, permanence, simplicity, durability, efficiency, and ease of maintenance are essential requirements.

To obtain permanency the equipment must be rugged in construction, of such material, in the case of steel mills and foundries, that the action of gases



A well designed system for steel mill lighting.

daylight—due to the cloudiness or the coming of evening. In addition, there are many plants which require artificial light throughout the day because of building construction.

Methods of Lighting.

There are three methods of lighting which may find application in the metal working industries. These are designated with regard to the placement of lighting units, and, with their relative advantages and disadvantages, are as follows:

General or Overhead Lighting—Such a system consists of light sources mounted overhead and insofar as possible symmetrically arranged to produce approximately uniform illumination throughout a given area. If properly designed, such lighting makes pos-

*From a lighting data bulletin compiled by the authors in the engineering department, Edison Lamp Works of General Electric Company, Harrison, N. J.

will not rapidly depreciate its reflective powers, and of such construction that the dust particles will not settle to a great extent on the reflecting surfaces.

It must be simple in design and not made up of complicated parts requiring great care in assembling and cleaning.

For local lighting at machines where there is considerable overhang of parts, and where light must be



Good lighting means good working conditions.

directed obliquely to the working point, or where it is essential to have adjustable mounting for the light source, an adjustable arm type lighting unit carrying a small deep bowl reflector should be employed.

Angle metal reflectors are used where especially high illumination is required on vertical surfaces and where lighting units must be located on the side walls or columns. They are frequently placed below the crane track and should generally be supplemented by overhead units. It is seldom, if ever, good practice to mount angle type units at a height less than 15 ft. above the floor, for a low mounting height usually results in the light source being within the line of vision of workmen and the resulting glare is a menace to eye comfort and safety. The spacing centers should be a distance approximately equal to one-half of the building width.

Prismatic and mirrored glass reflectors also find application in plants of the type under discussion. These can be very efficient and give suitable distribution of light. While it is evident that the likelihood of breakage is much greater than where metal reflectors are employed, the hazard is not as great as is often assumed. Where buildings are extremely high and surroundings relatively dark in color, it is desirable to use a type of unit which projects the light from the lamp strongly downward. Reflectors which are particularly adapted to this service are found in those of prismatic and mirrored glass construction.

Wherever units are mounted above the craneway, suitable units on the same or equivalent centers should be mounted on the bottom of the crane bridges so that ample light will be provided at all points at all times regardless of the crane position.

It will sometimes be found that there is not sufficient clearance between the crane and roof truss to permit the mounting of units from the bottom of the trusses. In such cases the units may be satisfactorily mounted by employing a support in the form of a "Z."

In some buildings, particularly those of the older type, considerable vibration is present and is transmitted through the structure, in the case of rigidly mounted units, to the lamps with such magnitude that excessive filament breakage results. By using a flexible mounting and, in the case of extremely severe vibration, a spring suspension, trouble due to this cause may be practically eliminated. There are on the market several commercial cushion hangers which are adapted to this service.

Enclosing or semi-enclosing units of opalescent or diffusing glass find some application in manufacturing operations and are especially suitable for the lighting of office spaces. They produce excellent diffusion with a slight sacrifice in efficiency. A room so lighted is generally agreeable and attractive. Conditions in a metal working plant are generally such as to make expedient the installation of indirect systems of lighting, but if unusually clean surroundings prevail the qualities of indirect lighting warrant consideration for some classes of work, particularly those in which high diffusion and a minimum of reflected glare is essential.

Floodlighting devices find use where lighting outlets must be located at a considerable distance from the point to be illuminated. Care should be taken in the placement of these units so that the workmen will not be facing the light. Such a condition will be dangerous from the standpoint of glare. With floodlighting it is desirable to direct beams from opposite directions at a given point as this practice tends to prevent sharp shadows. Care must be taken in the mounting of overhead yard lighting units so that they will not interfere with the operation of locomotive cranes as they move about the yards.



Lighting in cold rolling department.

Lamps used in open bottom reflectors mounted less than 20 ft. above the floor should be of the diffusing bulb, i.e., inside frost or white bowl type, in order to insure a minimum of glare and to make any shadows that do exist soft and feathery. Units mounted above 20 ft. may employ the clear lamp.

Whatever system of illumination is chosen, it is good practice to provide light colored walls and ceil-

ings and to refinish these at frequent intervals. Thus light which would otherwise be wasted is conserved.

The importance of a well-supervised, carefully planned system of cleaning lamps and reflectors cannot be over-emphasized. Many a complaint of poor lighting conditions is due to a marked diminution in intensity resulting from an accumulation of dirt and dust. The effects of this are far greater than casual thought would indicate.



An adequate lighting system for coarse work.

In many plants lighting circuits are not separate from power circuits and 220-volt service is employed with either 220-volt lamps, or two 110-volt lamps in series. Although such operation may represent an initial economy in copper as compared to a 110-volt system the disadvantages, higher lamp cost, lower lamp efficiency, and inherently less rugged lamp structure more than offset this slight gain.

The disadvantage of operating two lamps in series and the superiority of 110-volt (nominal) lamps for general lighting service are too well known to require discussion here. The practice of operating lighting circuits from d.c. power feeders, particularly where heavy loads are thrown on and off the line, is extremely objectionable as severe voltage fluctuation is prevalent due to the constantly changing load on the generators. This results in bad flickering of the lights and, of course, affects the life and light output of the lamps. Furthermore, the shutdown of a power unit may mean throwing the plant in darkness at the very time when adequate lighting is most required. Substantial economies and convenience can be effected by the use of 110-volt lamps, and in new installations this voltage should unquestionably be adopted. In the case of those now in operation a thorough investigation should be made of the various simple and economical means available for changing, with a view toward ascertaining the advisability of adopting the 110-volt service.

Separate lighting circuits, or, in the case of a.c. drive, high-voltage distribution with a step-down through transformers, with buck and boost regulators where voltage variation is extreme, are best adapted to the producing of satisfactory lighting.

Steel Mills and Foundries.

Large areas, high ceilings, dark surroundings, a smoky, dust-laden atmosphere and, particularly in steel mills, comparatively few workers, considering the spaces involved, are characteristic of all buildings.

The dark surroundings make it desirable to use equipment which does not depend upon the walls or ceilings for reflection, but directs its light toward the work. The light, particularly in foundry work, should be of a character sufficiently diffused to penetrate the molds, but should also have enough directional characteristic to bring out detail in its true perspective. Too great diffusion will give a flat appearance, so much so, perhaps, that the juncture of different planes may become indistinguishable and cause serious errors in molding.

Certain operators, particularly in foundry practice, feeling that they must keep their expenditure for lighting at an absolute minimum provide only a low intensity of general illumination, supplementing this by drop lamps. This practice is rarely satisfactory and a general lighting scheme is always to be preferred for the reasons previously outlined. From a lighting standpoint a rather peculiar condition exists in this industry, in that, in the case of many operations, ample light at the working point is furnished by the incandescent metal undergoing manipulation. As, for example, at the soaking pits, blooming mills, charging and tapping floors of the open hearth. This situation, however, rather than permitting the use of a lower intensity of light, as might seem likely on hasty consideration, actually calls for a somewhat higher value than would otherwise be the case. The reason for this is that the incandescent metal is a source of high brilliancy upon which the worker's gaze falls with a greater or less degree of intermittency. If the adjoining areas are dark the eye does not see clearly and, in fact, is blinded as it moves to the dark surroundings from the bright work, and vice-versa.

The wider the contrast in intensity the greater the degree of readjustment, and the longer the time required by the eye to adapt itself as it moves about. Thus production is lowered and the accident hazard



Combination of general and local lighting.

increased if adequate general lighting is not provided. The illumination provided should permit the movement of the eye from place to place without the necessity of undue readjustment, and should be of such an intensity that the workman can find tools, inspect and make repairs, carry on his work with celerity and comfort, and be safe from accident regardless of the presence or absence of hot light giving metals. Further-

more, it should be free from objectionable glare and so distributed as to prevent harsh shadows.

The size of the area to be lighted and the permissible mounting height of the units will govern their number and arrangement. The rule of thumb as previously given, "the spacing of outlets should be about equal to the mounting height," may safely be followed. Naturally a few large units will be less expensive from the standpoint of both initial and operating expense, but if too few are employed uneven distribution and harsh shadows will result and the illumination will be far from satisfactory.

In buildings which are exceptionally high as compared to their width and where the use of overhead cranes makes a very high hanging of overhead units necessary, a large volume of the light from the units would be incident on the upper wall area if deep bowl reflectors were used. With the customary dark condition of these surfaces the resulting reflection would be so low that the illumination secured would be only at the expense of a severe sacrifice in efficiency. In such interiors, therefore, it is usually desirable to employ units of the mirrored or prismatic glass type, mounted overhead, giving a concentrated distribution, or angle type enameled steel reflectors mounted below the crane rail and preferably supplemented by overhead general illumination.

The majority of the operations in typical steel mills, such as the charging and tapping of open hearth furnaces and blast furnaces, molding, stripping, mixing, rough shearing, soak pit, blooming mill, rail mill operation, pickling, galvanizing, tinning, dusting, etc., are of a rough and semi-automatic nature; over 80 per cent of the output being completely processed without being touched by human hands. The lighting demands in most of these areas are fulfilled by a medium intensity of general illumination. In other operations,

a localized unit of the angle or small flood type trained on the face of the indicator. Close shearing calls for light which is of such direction as to illuminate the shear blades and cutting line. The proper position for the outlet is usually above and slightly in front of the operator. On large shears with considerable overhang localized general or local lighting is advisable.



Adequate lighting minimizes accident hazards.

Tin-plate sorting and inspection is undoubtedly the most exacting work encountered in sheet mill operation. A light source having a large area producing illumination of high diffusion is essential in order that trying specular reflections may be avoided and imperfections and flaws in sheets made readily visible.

In some mills where special study has been given to this problem, lighting units have been improvised making use of a dome-shaped deep box, finished on the inside with a white enamel paint, carrying lamps mounted in a trough around the lower edge in such a manner as to throw their illumination up inside the box from where it may be diffusely reflected on to the inspection area. With such an arrangement the size of the light source is virtually the entire area of the inside of the box, and the effect of an artificial sky is produced.

Vapor-proof fittings are desirable on the lighting units in the mixing houses and areas adjacent to the Bessemer converters, as minute particles of graphite from the operation of this equipment lodge on all exposed parts, and are frequently the cause of considerable trouble through short circuits where this precaution has not been taken. In the pickling Department, where more or less corrosive fumes are present, vapor-proof fittings are necessary.

As floor moulding and pouring are carried on within the same area, though at different times of the day, the lighting system will be the same. Moulding calls for the greatest accuracy and is usually done during the early hours of the day. For pouring and stripping the lighting demands are less exacting. This work is carried on during the latter part of the day when natural light is poor and the air in the foundry is full of dust and gases. However, if provision is made for proper light for moulding, a lower, though



A well lighted foundry.

such as cold rolling, inspecting, shearing by fine line, tin-plate sorting, structural steel layout, etc., a comparatively high intensity of well diffused light is essential, and higher wattages utilizing carefully planned general and localized general lighting are best applied.

In rolling mills, where vertical face indicators and gauges must be distinctly visible at all times, it is advisable to supplement the general illumination with

adequate, intensity will automatically prevail for pouring and stripping.

The lighting of bench moulding, machine moulding, and core making, which calls for some discrimination of detail, since the pieces turned out are usually small and must be accurately moulded, can best be accomplished by what is termed a "localized general" system. A high intensity is required along the row of machines or benches, while a lower illumination is sufficient for the remainder of the room. This effect of varied intensity is obtained by placing the lighting units relative to the machines. The maximum intensity is thus delivered from the correct direction and the spread of light takes care of the surrounding areas. Such a system has practically all the advantages of the drop light in getting the light where it is needed and yet the lighting units are not within reach.

The work of charging, tumbling, and cleaning is of a relatively rough nature and requires little discrimination of detail. Distribution should be such that harsh shadows and dark corners will not be the result, and that hatchways and pits will be readily visible.

In the following table are listed the intensities which experience indicates are desirable for various processes in steel mill and foundry work.

Thoroughfares	0.1 - 0.5
Ore yards	0.1 - 0.5
Loading yards (no inspection).....	0.25- 1.0
Loading yards (inspection).....	0.25- 1.0
Open hearth mould yards.....	0.25- 1.0
Stock houses	0.5 - 1.0
Open hearth charging floors.....	1.0 - 2.0
Open hearth casting floors.....	1.0 - 2.0
Soaking pits	1.0 - 2.0
Reheating furnaces	2.0 - 4.0
Puddling furnaces	2.0 - 4.0
Annealing furnaces	2.0 - 4.0
Blast furnaces	1.0 - 2.0
Cast houses	1.0 - 2.0
Mixing houses	2.0 - 4.0
Bessemer (converter houses).....	1.0 - 2.0
Bessemer (blower's platform).....	3.0 - 6.0
Ingot stripping	1.0 - 2.0
Blooming mills	2.0 - 4.0
Cooling tables	2.0 - 4.0
Rail and structural mills.....	2.0 - 4.0
Pipe and tube mills.....	2.0 - 4.0
Chipping	4.0 - 8.0
Hot mills	2.0 - 4.0
Cold rolling	4.0 - 8.0
Shearing (close)	8.0 -12.0
Inspection (general)	4.0 - 8.0
Wire drawing	4.0 - 8.0
Pipe threading	4.0 - 8.0
Nail making	4.0 - 8.0
Pickling	2.0 - 4.0
Tinning	4.0 - 8.0
Tin plate sorting and inspecting.....	10.0 -15.0
Warehouses	2.0 - 4.0
Shipping	3.0 - 6.0
Machine shops	4.0 - 8.0
Power houses	4.0 - 8.0
Layout and fabrication (structural steel)	4.0 - 8.0
Foundries:	
Floor moulding and casting:	
Heavy castings	4.0 - 6.0
Small castings	6.0 -12.0
Bench moulding and core making....	8.0 -12.0
Charging tumbling and cleaning.....	3.0 - 6.0

Offers Course in Accident Prevention

In an effort to check the rising tide of industrial and public accidents and in response to the demand from all parts of the country for trained leaders in safety work, New York University, with the co-operation of the American Museum of Safety, will offer

next month the first collegiate course in accident prevention, it was announced here today by Arthur Williams, President of the American Museum of Safety.

Citing reports from state and federal officials which show increases in industrial accidents ranging from 5 to 50 per cent in recent years, and reports from cities throughout the country showing equally startling increases in street and home accidents, Mr. Williams declared that the decision of New York University to train men and women for leadership in accident prevention work is one of the most significant developments since the beginning of the safety movement.

"The fact that most accidents are preventable was demonstrated 18 years ago," Mr. Williams said. "The methods of preventing accidents, both in industry and in communities, have become thoroughly standardized and detailed information concerning these methods—the combined experience of hundreds of companies and communities which have succeeded in reducing accidents from 25 to 75 per cent—is available to anyone. The need now is for men and women with the qualities of leaders and organizers, and with the training of safety engineers and public safety directors such as will be offered by New York University."

The course in accident prevention will be given under the direction of C. W. Price, vice president of the Elliott Service Company, formerly general manager of the National Safety Council and director of safety in the International Harvester Company. Other instructors in the course will be Dr. E. George Payne, professor of educational sociology at New York University, formerly chairman of the educational section of the National Safety Council and author of numerous books on health and safety for children; W. Graham Cole, director of safety, Metropolitan Life Insurance Company, formerly manager of the Washington Safety Council and safety engineer of the Bethlehem Steel Company; and Louis Resnick of The New York Edison Company, formerly editor of the National Safety News and director of publicity for the National Safety Council.

The announcement of the course declares: "The growing recognition of the need for checking the enormous human and economic loss due to accidents, bringing about an ever-increasing demand for men and women competent to organize and direct accident prevention campaigns in industry and in communities, has resulted in the development of a new profession, the members of which are variously termed Safety Engineers, Directors of Public Safety, or merely Safety Men. In recognition of this development and because there is at present no school offering courses in safety engineering or in public safety campaign management, New York University is offering a course to equip men and women for leadership in this new field of work.

"Of the 84,000 deaths and the 2,000,000 injuries and the loss of more than \$1,000,000,000 resulting from accidents in 1925 not more than 10 per cent could have been prevented by any additional mechanical guards or equipment.

The course in accident prevention will open to all graduates and undergraduate students in New York University and the employees in the industries which are members of the museum of safety and also to insurance safety inspectors, governmental officials and employees, industrial safety committee men, and others who through previous training or present association are interested in accident prevention.

Determining the Weight of Alloy Additions

The Author Has Prepared a Series of Curves Which Make It Possible to Quickly Determine the Amount of Ferro-Alloy to Be Added to Any Weight of Charge

By R. S. KERNS*

CURVES or charts of various descriptions have been used for years to present in a concrete way statistics, data, etc. It is much easier to see the changes brought about by different conditions when plotted with two or more variables than to visualize the change when the data or figures are all set down in columns.

The manufacturer uses a curve to show his daily production, his daily shipments, his profits over a determined length of time, and for numerous other purposes. He is then able to tell at a glance from the curves whether his daily production is increasing or decreasing, how his profits vary from one period to another, and other useful information without having to wade through a lot of figures or daily balances.

Curves are interesting and when kept in good form present the whole story in a clear legible manner. The writer had a very good friend in his class at college who might well be said to have had the "curve bug." He plotted curves to show his weekly, monthly, and yearly expenditures while attending college; a curve of the temperature taken every morning at 7:00 o'clock; a curve showing the amount of time put on each study during his entire college career, but perhaps the most interesting one was what he called his "love curve." He probably never showed this to his future wife as it had quite a few drops and irregularities. When he received her letter there would be a decided rise in the curve, then when he went to a dance with a college girl the curve would show a drop, at vacation times there would be a rise in the curve and for several days afterward when it would again slope downward.

Recently, there was published a list of constants, in another magazine devoted to foundry interests, to be used as a quick method for determining the weight of ferro-alloys to be added to a heat of iron or steel when the weight of the charge was known and the percentage or "points" the alloy was to be raised in the heat to meet the required analysis. These constants were limited to a predetermined percentage of alloy in the ferro-alloy, as 80 per cent manganese in ferro-manganese, 50 per cent silicon in ferro-silicon, etc. Should the percentage of alloy run above or below these values, the constants would be of no use.

While ferro-manganese and ferro-silicon run fairly uniform in their alloy contents, yet some of the ferro-alloys vary quite a bit, as, ferro-chromium which varies from 60 to 70 per cent chromium, ferro-tungsten varies from 70 to 80 per cent tungsten, ferro-vanadium varies from 30 to 40 per cent vanadium, this also holds true for the carbon content of the various ferro-alloys. Thus, it is not possible to use the constants for values other than those for which they were calculated. By means of a curve or chart these intervening values can be found at once.

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The writer has prepared a series of curves or a chart which makes it possible to tell the required weight of ferro-alloy to be added to any weight of charge when the weight of charge, the percentage of alloy in the ferro-alloy, and the percentage or number of points the alloy is to be raised, are known. However, for increases of more than 1.00 per cent or 100 points of the alloy, a formula should be used which takes into consideration the increased weight of the charge due to the addition of the alloy. This formula is discussed later in the article.

Explanation of the Chart.

The different columns and rows of figures on the chart have been designated as A, B, C, D, and E. On the left hand side of the chart column A shows weight of the charge in pounds; column B represents the percentage of alloy in the ferro-alloy or carbon in pig iron, in fact, any percentage of any element can be found in this column. Along the top of the chart in row C there is given the pounds of ferro-alloy or pig iron (in case carbon is to be raised) to be added to the heat for every 1000 pounds of charge, these weights continue down the right hand side of the chart. At the bottom of the chart it will be noticed the figures are used for two purposes, namely, row D contains the points or per cent the element is to be raised to meet the final analysis, and row E shows the weight of ferro-alloy or pig iron to be added to the charge shown in column A.

The following examples will serve to show how the chart is used:

Example 1—Having a heat of 1000 pounds in the furnace and the chemist reports the manganese to be raised 70 points. The ferro-manganese containing 80 per cent manganese. To find the weight of manganese required: In line D at the bottom of the chart go over to 70 then project straight up this line to the horizontal line opposite 80 in column B, now move up between the two diagonal lines to the top of the chart, and on line C read $8\frac{3}{4}$ pounds, which is the weight of ferro-manganese required to raise 100 pounds 70 points or 0.70 per cent.

Example 2—If the heat is 6500 pounds instead of 1000 pounds, then don't go up between the two diagonal lines as you did in Example 1, but go down between these two diagonal lines until you intersect the horizontal line opposite 6500 in column A, then drop straight down to the weight shown in row E, which will read 57 pounds, or it will require 57 pounds of 80 per cent ferro-manganese to raise a heat of 6500 pounds 70 points.

Example 3—To raise the silicon 20 points in a heat of 8800 pounds. The ferro-silicon to contain 50 per cent silicon. At 20 in row D project straight up to opposite 50 in column B, follow the diagonal upward from the intersection of 20 and 50 until you intersect the line opposite 8800 in column A, now drop straight down to row E and read 35 pounds, or it will require

35 pounds of ferro-silicon to raise a heat of 8800 pounds 20 points or 0.20 per cent.

Example 4—Should the melter wish to know how much the carbon was raised in Example 2 by the addition of 57 pounds of ferro-manganese to the heat of 6500 pounds, it can be found as follows: The ferro-alloy in question contains 6.0 per cent carbon. From 57 pounds at the bottom of the chart, go straight up to the weight of the charge or 6500 pounds, then follow down between the diagonal lines from this point until the line opposite 6 in column B is reached, then drop straight down from here to row D, and read 5 points. Thus it will be seen that 57 pounds of ferro-manganese added to the heat raised the carbon 5 points, or 0.05 per cent.

as the physical character of the ferro-alloy, if added fine or in large lumps, if added to the ladle or the furnace, to furnace construction, or to melting conditions. Most melters know their melting losses and can allow enough in addition to the weight found in the chart to make up for the losses.

A chart of convenient size could be constructed and hung under glass near the furnace where the melter could have ready access to it; a good size would be 3 feet long and 2 feet high. Care should be taken in deciding where the diagonals above 15 cross the right hand vertical line, these points can be determined by the rule of similar triangles. With a little practice the melter should be able to tell almost at a glance without any calculations whatever,

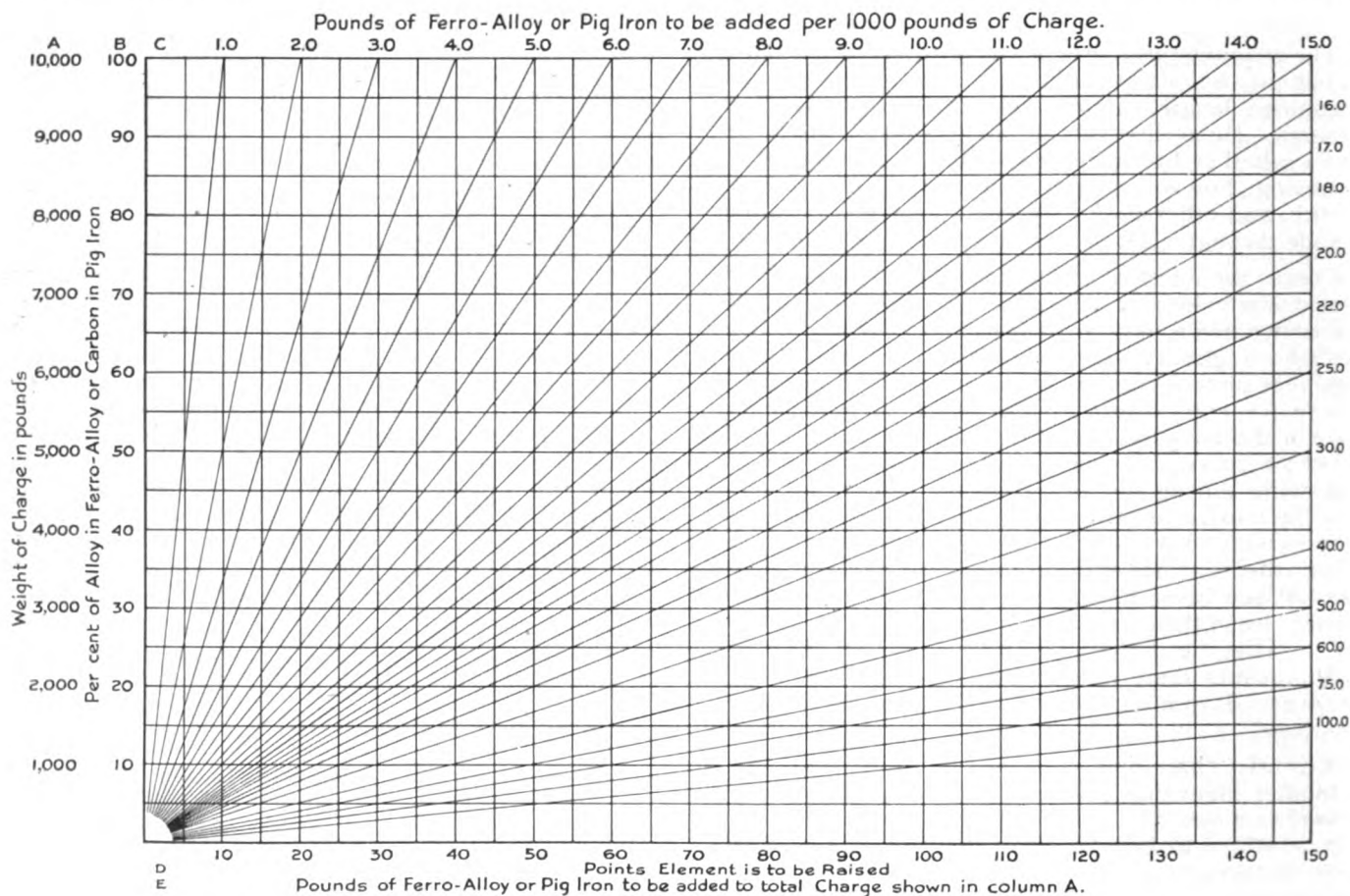


Chart for determining the weight of ferro-alloy to be added to a charge.

It will be noticed in column A the weights run to 10,000 pounds. Should a charge be more than 10,000 pounds all that is necessary is to select the charge which will be one-tenth of the weight, in column A, for instance, should the heat weigh 26,000 pounds, the weight of alloy required would be read from the weight of 2600 pound charge and the resulting weight of ferro-alloy as found would then be multiplied by 10, this would give the required weight of ferro-alloy for the 26,000 pounds. From this it can be seen there is no limit to the weight of charge to which this chart is applicable.

The weights of ferro-alloys and pig iron obtained from this chart do not take into account the melting loss of the alloy, but is based on 100 per cent efficiency or absorption of the alloy. Some melters have alloy losses of 10 per cent, others 15 per cent, while some run as low as 5 per cent, this depends on such factors

what weight of alloy bearing material is to be added to the heat to bring the alloy in question to its required percentage.

Calculating Alloy Additions Above 1.00 Per Cent.

When a particular element is to be raised more than 1.00 per cent, it is necessary to consider the weight of alloy bearing material added to the charge, in addition to the weight of the charge itself, using the sum of the two weights as the weight of charge upon which to base the alloy calculations. In other words take a common example as follows: Having an initial charge of 10,000 pounds and it is required to raise one of the elements 1.50 per cent in order to meet the specifications. Assume the alloy to be added 100 per cent pure. Without considering the increased weight due to the addition of the alloy, we would have 0.15 times 10,000 or 1500 pounds of alloy required. Now if we

add this amount of alloy to the heat, there will be 10,150 pounds in the furnace and the 150 pounds will be spread throughout this weight. The resulting analysis will not show 1.50 per cent but will be 150 divided by 10,150 giving 1.478 per cent. This is not far off the required percentage, but if the element were to be raised 5.00 per cent or 30.00 per cent there would be a great difference between the first method and the correct method.

In order to calculate for large additions of alloys or weight of pig iron to give more than 0.10 per cent increase in carbon, the writer has developed the following formulae:

$$X = \frac{cP}{a - P}, \quad P = \frac{aX}{c + X}, \quad C = c + X,$$

In these formulae

X is the weight in pounds of ferro-alloy or pig iron required.

c is the weight in pounds of the initial charge.

a is the percentage of alloy in the alloy bearing material.

P is the percentage the alloy is to be raised.

C is the weight in pounds of the final charge.

The following are some examples which will serve to show how these various formulae are used:

Example 1—Given: Initial charge weighs 12,200 pounds.
Nickel is to be increased 3.20 per cent.
Nickel used is 98 per cent pure.
Required: The weight of nickel necessary.

Using the formula

$$X = \frac{c \times P}{a - P}$$

and substituting the correct values we have

$$X = \frac{12,200 \times 3.20}{98 - 3.20}$$

or X = 411.8 pounds of nickel required.

In order to prove this we use formula

$$P = \frac{a \times X}{c + X}$$

Substituting correct values we have

$$P = \frac{98 \times 411.8}{12,200 + 411.8}$$

Example 2—Given: Initial charge weighs 17,000 pounds.
Manganese is to be increased 12.50 per cent.
Ferro-manganese contains 80 per cent manganese.
Ferro-manganese contains 6.50 per cent carbon.
Required: Weight of ferro-manganese required.
Increase in carbon content due to the manganese addition.

Using the formula

$$X = \frac{c \times P}{a - P}$$

and substituting the correct values we have

$$X = \frac{17,000 \times 12.50}{80 - 12.50}$$

or X = 3,148 pounds of ferro-manganese required.

Proving this by using

$$P = \frac{a \times X}{c + X}$$

and using correct values we have

$$P = \frac{80 \times 3148}{20148}$$

or P = 12.50 per cent manganese.

In order to determine how much the carbon has been increased use the formula

$$P = \frac{a \times X}{C}$$

and using correct values we will have

$$P = \frac{6.50 \times 3148}{20148}$$

or P = 1.02 per cent, the amount the carbon has been increased due to the addition of the ferro-manganese.

Example 3—Given: Initial charge weighs 9,000 pounds.
Carbon is to be raised 0.12 per cent.
Pig iron contains 3.50 per cent carbon.
Required: The necessary weight of pig iron.

Using the formula

$$X = \frac{c \times P}{a - P}$$

and substituting the correct values we have

$$X = \frac{9000 \times 0.12}{3.50 - 0.12}$$

or X = 319.5 pounds of pig iron necessary.

Proving this by formula

$$P = \frac{a \times X}{C}$$

and substituting the correct values we have

$$P = \frac{3.50 \times 319.5}{9319.5}$$

or P = 0.12 per cent.

The Hoskins Iron & Steel Company, Sydney, Australia, is preparing plans for a new blast furnace on site at Port Kembla, about 50 miles from Sydney, and expects to proceed with work by the close of the year. The unit will have a capacity of 450 tons and will be provided with modern auxiliary equipment.

The Question of Plastic Deformation*

The Author Gives an Insight into the Character of Plastic Deformation—Various Observations and Theories Discussed—Application to Rolling, Forging and Pressing

By H. PREUSSLER

THE last few years have brought forth considerable progress in the mathematical determination of deformation forces and deformation energy, but less important ones in the explanation of the shape of plastic bodies. In spite of numerous individual observations there is no conformity in its explanation aside from a few fundamental ideas; nevertheless, the numerous efforts made for the purpose of arriving at a satisfactory explanation show a steadily increasing agreement of opinions, apparently opposite sides showing more accordance than their defenders would surmise. An insight into the character of plastic deformation may be obtained by answering three basic questions:

What shape is assumed by a plastic body of simple shape when it is compressed, all disturbing influences being eliminated?

What deviation is produced by the friction between the plastic body and the pressure surfaces?

What deformation is produced in a plastic body due to unequal distribution of pressure and mass?

The expression "pure energy of deformation" is known. The first question also is equivalent to the one concerning the law of pure or ideal deformation. The answer is simple, almost self evident; if the shape of a compressed body deviates here or there from the original shape of the section, it is presumed that the original form should have been maintained and variations from it are ascribed to other influences. Practice confirms this theory. Slender cylinders or prisms, when compressed, show bulges only near the end surfaces, the uninfluenced middle part retains its originally round or polygonal shape longer. If the end surfaces are well greased, or the friction is eliminated in some other way, for instance by superimposing three homogeneous bodies, these irregularities disappear. When low, rectangular prisms, Fig. 1, are compressed there is a strong tendency for the specimen to bulge, Fig. 2, if no precaution is taken to eliminate friction. However, if the pressure surfaces are lubricated, a tendency to maintain a rectangular shape, similar to the original one, will be noticed, Fig. 3. A tensile test bar of any section will maintain the form of this section.

Therefore, experience entitles us to assume an ideal law of deformation which would be expressed as follows: Bodies of a prismatic or cylindrical form, being compressed (or drawn) in axial direction with the elimination of other influences, retain cross sections which are similar to the original.

Although this law is one of the fundamental hypotheses for the theoretical investigation of the deformation forces, and has been applied as such, it has, until now, hardly ever been cited.

What influence has the pressure surface friction upon the deformation? Its importance has been and is yet strongly contested. Based on certain observations some believe the cause of the bulges in pressure

cylinders are the result of friction, while others explain it by the penetration of slip cones. As has been shown lately by Rummel and by others, no bulges occur with the reduction or elimination of friction. The explanation that bulging may result from either friction or slip cones does not necessarily indicate that the two theories conflict for they must both be considered as two different factors entering into the same question.

No doubt, friction is the primary cause of bulging; but would it not be possible that slip cones form as a result of friction? If we succeed in preventing bulges by reducing or eliminating friction, it will not indicate the absence of slip cones, but is evidence in favor of the law of pure deformation. The actual existence of slip bodies can only be proven or contested on bodies with bulges. Nevertheless, there are important reasons to disprove this theory. First, slip cones must be very changeable formations; since the degree of bulging changes correspondingly with the amount of friction. Therefore, the slip bodies (friction bodies) should vary to the same extent.

This theory may conflict with the many explanations of the process of rolling, where, notwithstanding the changing conditions of friction, rigid geometrical slip bodies are assumed to form above the point of contact with the roll. Second, according to Rummel, observation proves that deformation also takes place inside of the slide cones. But it would be wrong to disregard entirely analogy in the formation of a sand heap. Should we drop the old and reliable atomic theory because everything cannot be explained with it and replace it by a complicated ultra-atomic planetary system? As long as we are aware of the expedient character of all these ideas, we must be tolerant towards their insufficiency.

The more the end surfaces approach each other, the stronger the influence of the friction becomes, and the less the deformation follows the ideal law of compression. With flat bodies the latter seems to be totally eliminated. Here the relations of this law will be revealed most clearly. Of the many attempts to explain the contour line of Fig. 2, the one offered by Falk is considered to best explain the peculiar bow shape of the sides. From the fact that each section tends to assume a circular shape, he drew the conclusion that the yielding of the material tends toward general relief of the resistances of friction, and, therefore, takes place in the reversed ratio of the opposing resistances, i. e., the distance of the outlines (contour lines) from the center of the surface. The assumption of the center of gravity of the area as the center of resistance at first glance seems logical, especially if the sections considered are not too irregular. Falk, no doubt, would have noticed the error had he extended his theory to extremely irregular sections.

To explain this, a square rod $\frac{3}{4}$ in. x $\frac{3}{4}$ in. and 12 in. long, may be compressed from $\frac{3}{4}$ in. to $\frac{1}{4}$ in. We will not obtain a plate with bulges on the long sides, as should be the case according to Falk, but a

* Published in *Stahl und Eisen*, No. 21, 1926.

widened flat bar with parallel sides and bows at the ends. Small bulges in the vertical sections of the contour lines may be disregarded. The reason for this change in the rod is that the resistances against deformation are bilateral and alike at a right angle to the axis of the bar.

This example suggests another interpretation. Each particle has to overcome the smallest resistance when the number of the particles it has to move is a minimum, which, consequently is in a direction at right angle to the circumference. All points of equal distance from the circumference (outline) are points of equal resistance. Therefore, by drawing into the cross section of any flat compression body, lines running at equal distance (parallel) from the outline, Fig. 4, a number of new lines *S* will be obtained which geometrically bisect the angles between the outlines, and represent lines of equal resistance with regard to the outlines. This system of lines *S*, determines the shifting of the material. It forms the "sheds" in the flow of the material.

By considering the action of water, or better of gravel, and how it settles at the foot of the mountain, a better conception of the flow of the plastic matter may be obtained; at the same time it gives an idea of the difficulty of finding a simple, comprehensive and quantitative expression for this multiform motion. It must be realized that the particles of material actually travel at right angle to the outline, at the same time it should be understood that this condition of motion holds for a short time only and for a small deformation, since with the yielding of the outline the direction of motion changes. A formation of corners is, therefore, impossible because the change in direction would have taken place previously during the flow. Nevertheless, this method makes it possible to judge the flow in flat bodies.

The formation of the new outline in Fig. 4 is based on the theory that the length of travel of a particle

indicates the peculiar law of the friction-compression process, which may be expressed as follows:

The compression of flat plastic bodies with parallel pressure (contact) surfaces subject to considerable friction, the particles flow in the direction of least resistance, i. e., at a right angle to the circumference. Their lengths of flow are in direct proportion to their distances from the respective "flowsheds" measured in the direction of motion. The travel of the material with regard to quantity and direction depends on the shape of the contour line.

The laws of ideal deformation and of friction compression cannot be considered alone, but always takes some intermediate form. Under the most ideal con-

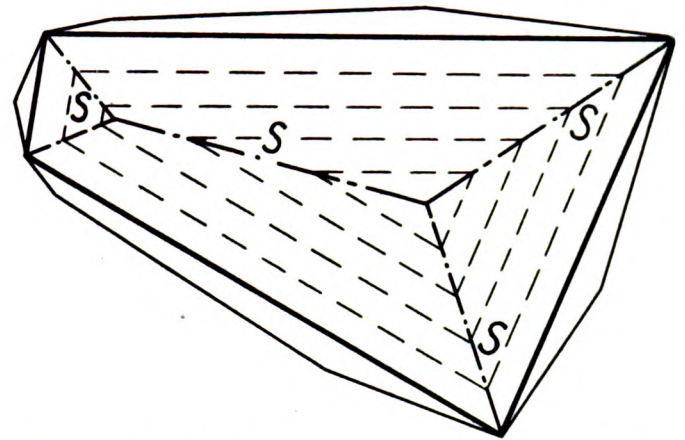


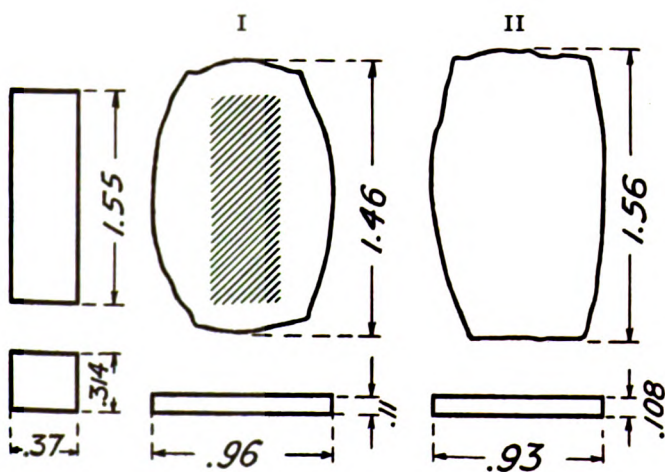
FIG. 4—Showing the deformation of a flat body under the influence of friction only.

ditions, according to Fig. 2, the corners move neither in the direction of the diagonals, which would correspond to the first law, nor in the bisecting line of the angles, but assume intermediate positions. This also explains the peculiar accentuation of the corners.

So far, the pressure has been assumed uniformly distributed over the total area. If parts are under unequal pressures, distortions will result which will also prevent a pure deformation. Parts under higher pressure try to pull along those under a smaller pressure and vice versa, the latter deviating the former from their natural direction of flow. The differences of pressure and the size of the parts of the compressed body in question are factors deciding the final shape. Due to the great variety of the possible conditions, no more than these general theories can be given. There is always a compensation of forces of different directions, and from their comprehension by calculation we are still far away. Tafel has occupied himself with these relations extensively and contributed much to clear them. Fig. 5 represents a practical example pertaining hereto.

Ideal deformation, influence of friction and the distribution of pressure and masses are the most essential form giving factors by the aid of which numerous observations may be directly explained. Usually they all act at the same time. The power required, increase in density of material and influence of plasticity, may be considered as immediate consequences.

The law of pure deformation represents the simplest case among the possible hypotheses. If the structure of a plastic body is assumed to consist of the smallest prisms or cubes, the law assumes that each of these elements is subject to the same law of deformation as the body as a whole. If two axes at right



FIGS. 1 to 3—Influence of the pressure surface friction on the deformation of lead prisms. Coating of paint preserved at I, distorted at II.

is proportional to its distance from the "flowshed," measured in the direction of motion. This assumption holds only if the circumference is composed of straight lines; however, the relation changes when the material moves radically as is the case at rounded section areas. It may be seen from the figure how, first the obtuse and then the acute angles disappear, and the section tends toward the shape of a circle. This

angles are placed in the middle of a body, the ordinate coinciding with the direction of compression, the ideal deformation is given when the ratio between shortening of the ordinates and lengthening of the abscisses is the same for all small cubes. This means, however, that all cubes retain their location with relation to each other.

This is not true for the smallest non-compressible parts, as they are bound to shift, but it may be concluded that the sum of the inner motions represents a minimum just as does the power required. If this law is to have general application, there follows a second law, viz., that for this kind of deformation, plasticity cannot be considered as an influencing factor. Both laws may be combined as follows:

At ideal deformation the power required is a minimum, the plasticity influencing the amount of power necessary but not the deformation.

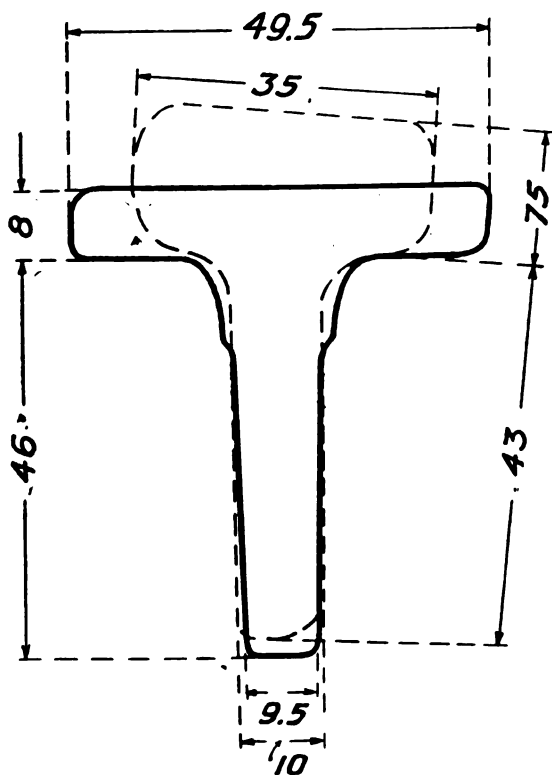


FIG. 5—Unusual spreading of a T-bar—14.5 mm instead of 2.5 mm—due to the influence of the uncompressed neck under the head.

If a process does not follow the law of pure compression, other forces enter into the deformation forces which require additional power to overcome. In this case actual changes in the location of material take place which are opposed by internal friction forces.

Suppose that the plasticity also plays a role in the deformation, for it is the expression of internal friction. That external forces, for instance the pressure surface friction are transformed into internal forces is shown by a simple experiment. The two original bodies used for the test given in Figs. 1 and 2 had been given an adhesive coat of paint. After the compression its shape was scarcely changed and was of the same size as the test body exposed to friction, but unlike the one coated with grease. This experiment, like similar ones conducted by other researchers, shows that external friction prevents almost entirely any change in the location of surface particles. The increase in pressure surface results in these cases from

swelling out of the sides. The particles of the contact surfaces, however, travel if the latter are well greased, thus distorting the coat of paint.

The deforming action of the internal friction may be conceived by remembering the different angles of repose of heaped material. It is proven by the different contractions and fracture shapes of tensile test bars and in addition by the varied action regarding filling and spreading of rolled bars, which are different in material and temperature. These forced motions of material are responsible for solidification and increase in density of the material; as before the material is squeezed into a new unnatural condition, it will harden as much as possible, therefore, it is natural to expect an increase in the amount of power required to accomplish this deformation. Of course, the stresses increasing to the breaking or tearing point will be the result of deformation, as happens in the process of rolling, but before this occurs the strength will have reached its maximum just as in the case of a normal tensile test.

With the simultaneous action of two laws of deformation, the more important conclusion follows that the amount of power required will depend upon the ratio in which both are active. It will be essentially higher if ideal deformation does not take place, therefore, with a forced deformation controlled by outside influences, the flow takes place unequally in the different directions—that is it follows one direction more easily than the other. It ensues that the amount of power required is the smaller, if deformation in one direction is greater than in other directions. Narrow sections are quite different from the round, requiring less power than those approaching a circular shape. The greatest resistance is offered by circular sections, which is the result of any deformation being continued far enough.

These two conclusions derived from observation may be easily confirmed by tests recorded in literature. Some are cited as follows: Foppl, who made pressure tests with granite cubes, found that cubes with greased contact surfaces broke at one-half to one-third of the load for ungreased cubes. It was characteristic that they split into columns. Sobbe noticed through his experiments that in the case of bodies of equal section but of different height, the higher bodies required a smaller relative deforming pressure, Figs. 6 and 7. He further observed that bodies of equal height and volume but of varied cross-section required varying amounts of power, the round cross-section requiring the greatest amount of power, Figs. 7, 8 and 9. He was not able to explain these observations. In Figs. 6 and 9, both cases are represented. The central sections of the bodies are those following ideal deformation. It will be noticed that actually the greatest amount of power is necessary where the ratio of impeded deformation to pure deformation is highest. The penetrating depth of the friction influences has been determined in all cases under uniform conditions (equal friction cone angles).

Riedel observed in his tests on prisms and cylinders that as the degree of compression increases, the specific pressure of deformation rises. In this way he traces the phenomenon back to the interference of friction bodies, slide bodies and the crushing of the slide bodies. Therefore, we can say that ideal deformation ceases where all parts of the bodies begin to move each other forcibly. A comparison between Riedel's opinion and the one here advanced is in favor of the double cone theory. Riedel's theory is based upon

the existence of friction cones (slip cones) whence he derives the unusually high specific deforming pressures, which in the opinion of the writer, results in an unequal distribution of pressure and masses, as shown in Fig. 10.

If a common cylinder with top and bottom enclosed by strong rings is compressed, the natural deformation of the cylinder is more strongly counteracted by the holding power of the rings than by exterior friction. A reduction of height is possible only when the rings are expanded. This is the simple explanation of the pressures of deformation being twice as great at the beginning. As the compression proceeds, the condition changes, the cylinder becoming larger and the rings weaker (Fig. 11). It may, therefore, be expected that the pressures related to the middle cross-section decrease also, and increase only after the influence of the pressure surface friction becomes greater. The test results confirm this assumption, but not that which is based on the speed of deformation.

The most important proofs in substantiation of the opinion presented here may be the rules set up by Kick about 40 years ago. He found first: The amount of energy required for like deformations of two geometrically similar bodies of the same material are in the same ratio as their volumes or weights. Second: The resistances offered by geometrically similar test pieces of different materials bear no constant ratio for the same deformations. The first rule can be directly understood and derived from the above. It is a special case of the general rule, that the ratio of non-ideal forming to pure forming determines the amount of energy required. The second rule, however, is an expression of the indefinite rule of plasticity appearing in non-ideal deformation. The conclusion from the friction compression law may be united as follows:

Compression bodies of materially the same characteristics require a greater amount of energy the less they are subject to pure deformation, and the more

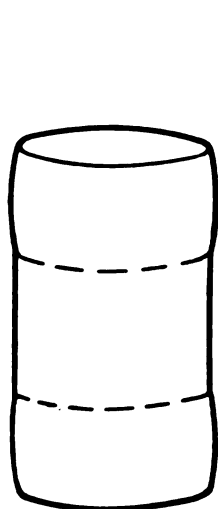


Fig. 6

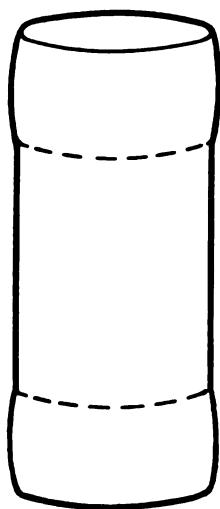


Fig. 7

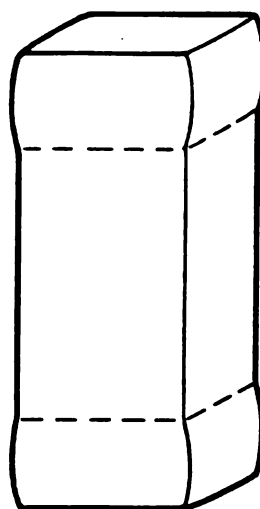


Fig. 8

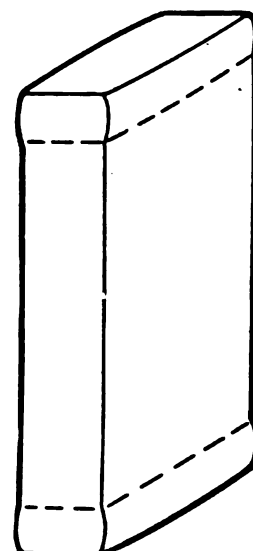


Fig. 9

FIGS. 8 to 9—The varying amount of power required with equal press strokes for bodies of the same material and section is explained by the unequal amount of unrestricted and restricted deformation.

Riedel may have taken the deforming speed for the lineal pressing speed, or speed of the ram. The former speed, corresponding to the relative compression will remain almost constant, because the pressing speed decreases. The same results should have been obtained with the tests on cylinders, but this was not the case. This disproves the opinion that considers the double cone test as something more simple than the test with common cylinder or prisms. In this sense the same holds true for the tensile test.

The "Period of Intensive Flow" as observed by both Riedel and Sobbe is also remarkable. It is associated with a noticeable decrease of the resistance against deformation and coincides with the pure deformation of the middle part.

The writer is inclined to assume that pure deformation causes no condensation but rather a breaking up of the structure, and might be considered the cause of this peculiar phenomenon. The process of rolling seamless tubes—where a round section by continued squeezing and turning is loosened inside so that it offers little or no resistance to the penetrating mandrel—may be regarded as based on this phenomenon.

they approach a circular section. The more forcible the movements of the material, the greater the amount of energy required and the more pronounced is the condensing effect. With non-ideal deformation the plasticity determines not only the energy, but also the forming.

The last discussion emphasizes more and more the practical value of the preceding research work. Questions, contested for some time, appear in a new light. The difference between the action of a hammer and a press is not to be repeated here, as a great number of these difficulties are clear to anyone recognizing the controlling influence of friction. It is sufficient to state that the press quite naturally favors the influences of friction, whereas with the hammer considerable differences may appear due to strength and number of blows, plasticity and masses. No doubt the influence of friction has so far been underestimated, or else we would not wonder why the material rises and flows less easily under the press, but is condensed to a greater extent than under the hammer. Dies for drawing, drop forging, and pressing of shells are greased not only to facilitate loosening, but also to

decrease the resistance of flow and the energy required. The last blows after the form is filled will give the material the necessary condensation. It will not be necessary to discuss any further the shape of forging or pressing tools. They represent accommodations to the law of friction compression with regard to special purposes.

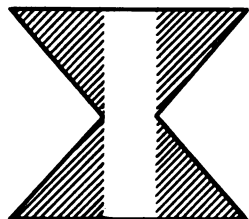


Fig. 10

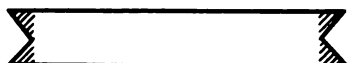


Fig. 11

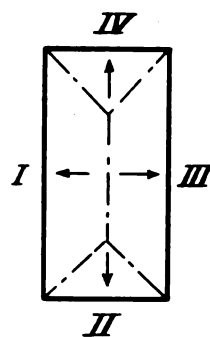
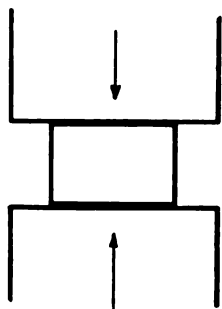


Fig. 12

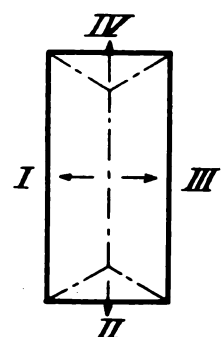
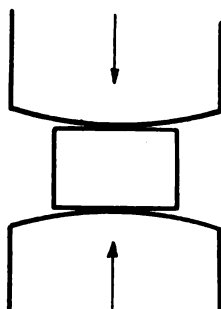


Fig. 13

FIGS. 12 and 13—Showing the influence of the shape of the tool and piece on the flow of the material.

The opinion exists that the process of rolling has to be taken as a compression-tension process, and certain observations, made by Trink, are cited as proof. Deciding for this point of view is the location of the acting forces with regard to the orifice (roll-pass). Accordingly this opinion fits the process of drawing, while the rolling has to be designated as "compression-push" process. Both cases are based on the process of simple compression. If a flat, square prism is compressed, without precaution, between two plain parallel surfaces, a system of flow sheds is created according to the law of compression with friction, Fig. 12. In this case the direction of flow is not influenced by the tools but by the shape of the work alone. At moderate pressure the amount of material flowing over the four sides may be assumed to be in the same ratio as the areas I to IV.

How does the picture change with rounded pressure areas? In this case the shape of the tool favors directions I to III. The system of center lines of resistances assumes, according to Fig. 13, a somewhat modified form which again points to the quantitative ratios of deformation. The double symmetry remains

as an essential characteristic. The rolling process resembles this latter process with one exception, viz., that the directions I and II remain favored as a whole but are unequally affected due to the influence of the rolls. The double symmetry of the "Flow sheds" changes to a single one, Fig. 14. As a consequence of this, an insight has been gained which allows of valuable conclusions.

At first it is shown that the material, if not hindered by force must necessarily yield towards all four sides, for otherwise no equilibrium is maintained. Accordingly, the flow-shed, a-b, is equivalent to that place of the compressed surface where the surface of the bar and circumference of the roll have exactly the same speed. In front and back, the material escapes partly by swelling and partly by sliding on the roll surface with which it is in contact. Spreading, deceleration and acceleration, for nothing else is represented by the material shoved forward in section I, are in closest relation, and the greater the first, the smaller the other two will be. As for the particles of section I and III, no other motion is possible than lengthwise.

The spreading is actually limited to certain marginal zones or "influence depth," which is governed by friction and the shape of the roll. For equal height of bars and changing width, the resistance of flow remain the same, but the ratio of the masses between the spreading and stretching parts change, Figs. 15 and 16. When going below the double width of marginal zone, the ratio of flow reverses; the main amount

TABLE I
Participation of Spreading and Stretching on the Total Displacement at Flats of Different Widths and Heights

Number	Height before and after the pass, Inches	Weights before and after the pass, Pounds	Lengthening at constant width $\frac{H_1 - H_2}{H_2} \div \frac{H_3}{H_2} = 100$ %	Actual Length's $\frac{W_1 - W_2}{W_2} \div \frac{W_3}{W_2} = 100$ %	Ratio of Lengthening of Spreading %	Ratio of Height before the pass Width
1	0.280	0.092	16.4	14.4	88:12	1:8.3
2	0.241	0.281	22.2	19.	85:15	1:8.0
3	0.260	0.578	31.	24.7	80:20	1:5.7
4	0.213	0.485	31.	24.7	80:20	1:5.7
5	0.216	0.087	16.7	12.3	74:26	1:5.0
6	0.166	0.070	12.3	9.4	70:30	1:5.0
7	0.276	0.345	23.1	16.6	72:28	1:3.9
8	0.236	0.307	19.6	9.4	48:52	2.0:1
9	0.209	0.131	9.7	6.0	58:42	4.5:1
10	0.154	0.104	5.8	3.1	54:46	4.6:1
11	0.252	0.171	4.9	1.8	38:62	6.3:1
12	0.205	0.147	6.9	3.5	51:49	6.5:1
13	1.11	0.196	4.3	1.2	28:72	8.8:1
14	0.930	0.179				
	1.07	0.182				
	0.98	0.171				
	1.21	0.263				
	1.15	0.255				
	0.96	0.063				
	0.86	0.060				
	1.51	0.358				
	1.39	0.345				
	1.29	0.089				
	1.24	0.087				
	1.22	0.076				
	1.14	0.074				
	2.19	0.585				
	2.10	0.575				

of the squeezed material can yield easier to the sides of the bar than to the front or back, Fig. 17.

These conclusions, based on simple hypotheses, agree with the repeatedly contested opinions of Brovot, Tafel, Scheld and others, without the necessity of

arbitrary assumptions. They are also confirmed in practice as shown in Table I. With wide flat passes, 90 per cent of the displaced volume goes into the length and only 10 per cent into the width, and the amount of the spreading increases as the passes grow narrower, reaching 70 per cent on high edging passes.

The method of ascertaining the percentage of lengthening consisted in cutting short pieces of equal

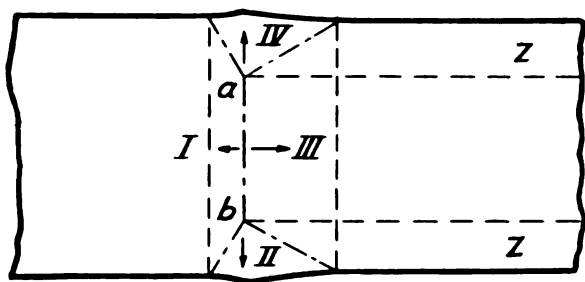
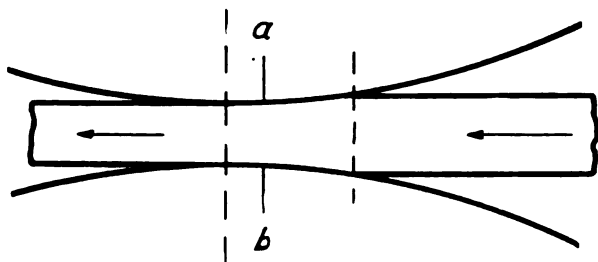


Fig. 14

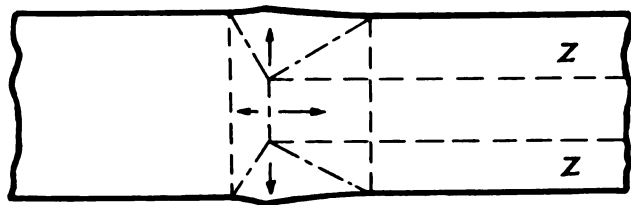


Fig. 15

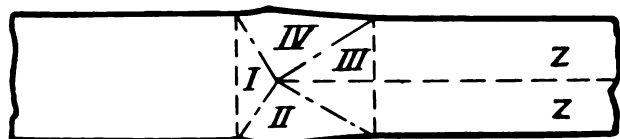


Fig. 16



Fig. 17

FIGS. 14 to 17—Showing the influence of the width of the bar on acceleration, spreading and deceleration when rolling. I. Zone of acceleration. II and III. Zone of spreading. III. Zone of deceleration.

length from the bars, before and after the pass, and weighing these pieces. The ratio of weights corresponds to the ratio of actual lengthening. The theoretical lengthening, assuming no spreading, results from the ratio of heights before and after the pass.

The percentage of spreading is to be calculated from the difference between both.

A further discussion of the special conditions influencing the amount of acceleration cannot be gone into here, but it may be said that from the relationship of the cases shown in Figs. 12 to 14, a series of conclusions were arrived at which have been confirmed elsewhere by test and experience. It must not be forgotten, that, in addition to the size of the section of acceleration, the pressures have to be considered greater in front of the "flow shed" than between it and the roll pass. With each investigation, all sides of the object should be considered while in this particular case we are limiting ourselves more or less to the occurrences in the horizontal plane only.

The contraction of the sides of a rolled bar, observed by Trinks, is convincingly explained by Tafel as a consequence of the material being entrained by the middle of the bar subject to greater lengthening. This process is more precisely defined by saying: By the "accelerated" position of the displaced material. If, due to small draft (Compression), small friction, large roll diameter or narrow bar, the acceleration becomes small, the laterally crowded material is carried along to a smaller extent and instead of contracted sides, straight or bulging sides will form. The limited zones of spreading as well as the diverging of the marginal zones could be clearly proven by Scheld.

In many regards, cold drawing is similar to the rolling. If a flat is reduced 10 per cent in one direction and does not contract the same amount in the other, it is a sign of external friction. On the other hand, the law of pure deformation cannot be ignored in the case of shapes, for instance channeled bars with contracted circumference. Before making the usual allowances for drawing, it should be remembered, that, according to the above law, a stretched section strived to decrease in cross section with the result that the groove becomes narrow and comes in contact with the die. If no allowance is made for reduction in width, the pressure on the die at the inside of the groove is increased to such an extent that no steel is strong enough to keep from breaking. There are many instances where ignorance of these simple facts has been the cause of failures.

Machine Tool Builders Announce Plans for Exposition

The National Machine Tool Builders' Association has issued a preliminary announcement of the first national machine tool builders' exposition, to be held in the Public Hall, Cleveland, September 19 to 24, 1927. The association states that plans are now under way for stimulation of selective attendance at the exposition. The general public will not be admitted, and all visitors will register. In this way, the association hopes to attract only representatives of companies which use machine tools.

Plans for the exposition are in charge of a committee consisting of J. Wallace Carrel, vice president, Lodge & Shipley Tool Company, Cincinnati, chairman; P. E. Bliss, vice-president Warner & Swasey Company, Cleveland; O. B. Iles, president International Machine Tool Company, Indianapolis; H. W. Dunbar, assistant general sales manager Norton Company, Worcester, Mass.; E. J. Kearney, secretary Kearney & Trecker Corporation, Milwaukee.

Treatment of Blast Furnace Flue Dust*

FLUE dust, which is made during the smelting of ores that contain appreciable quantities of fines, is one of the troublesome products of the iron blast furnace. Gases that issue from the furnace at a high velocity carry small particles of coke, ore, and flux into dust-collecting chambers; these particles constitute the flue dust. Losses of iron ore through the production of flue dust vary between wide limits in different furnaces and depend upon a number of factors such as size and design of furnace, amount of fines in the ore, operating conditions, and blast pressure.

Blast-furnace operators of the Birmingham district, Alabama, keenly realize this waste. The ores are relatively low grade and require more fuel than is ordinarily used elsewhere; hence, the flue dust is low in iron content and high in coke and it is not in suitable condition for direct sintering. In many other iron and steel centers, direct sintering is common practice. In the Birmingham district, efforts have been made to prevent this loss by re-charging the dust into the furnace, but, as might be expected, a material fine enough to be blown out once will most likely be carried over again.

In general, the flue-dust losses in this district will average 250 pounds per ton of pig iron produced, but at times the losses at different furnaces are substantially higher or lower than this figure. On the basis of the present rate of pig-iron production, the annual loss of flue dust exceeds 300,000 tons. The iron content of the dust probably averages 25 per cent, therefore, about 75,000 tons of iron is wasted yearly, or about 3 per cent of the iron mixed is lost in flue dust. The operators of the district are endeavoring to prevent this waste, and it was at their request that this investigation was undertaken by the U. S. Bureau of Mines.

Characteristics of the Ore.

The red ores of the district require very fine grinding to free the mineral from the gangue, gravity concentration is not feasible. As the important constituent of this flue dust is red ore, gravity concentration need not be considered except for removing coke. On the other hand, if the iron mineral has been reduced to magnetite, magnetic concentration is a desirable method to apply.

The chemical contents of the flue dusts vary through a wide range. The percentage of iron mainly depends upon the grade and kind of ore charged to the furnace. As a rule the flue dust of highest iron content comes from furnaces which smelt a large proportion of brown ore, and the leanest dust comes from smelting only red hematite.

All of the characteristics described in the preceding paragraphs influence the problem of concentration. In addition to these, the magnetic property of the iron minerals in the flue dust is another factor of importance. As will be shown, a flue dust which has been well reduced and hence contains a large proportion of the iron mineral as magnetite, is readily amenable to concentration.

*Excerpts from Bureau of Mines Reports of Investigations No. 2761, July 1926, by Oscar Lee, B. W. Gandrud and F. D. DeVaney.

Composition of Flue Dusts.

Table I shows the composition of a variety of flue dusts investigated.

TABLE I—CHEMICAL ANALYSES OF A VARIETY OF FLUE DUSTS

Flue Dust No.	Assay, Per Cent					
	Iron	Insoluble	Lime	Phosphorus	Sulphur	Carbon
1	21.6	11.9	13.2	0.22	0.16	30.6
2	22.1	17.8	9.6	.21	.17	26.5
3	24.3	17.5	6.7	.26	.18	30.1
4	29.6	20.2	10.9	.24	.10	11.6
5	30.0	18.6	11.4	.23	.13	18.1
6	36.8	13.8	7.8	.21	.28	15.2
7	45.8	14.0	2.9	.09	.18	10.8

Other samples were examined, but as they were from the same furnaces and very similar to those tabulated above they are not included. No two of these flue dusts are similar in composition, and hence no one of them can be regarded as representative of the group. Only No. 1 is self-fluxing; the others are deficient in lime content. In a general way the carbon content of the dust varies inversely as the iron.

Screen-Sizing Analysis of Flue Dust.

Each of the seven samples was screened to determine the proportion of sizes present, and Table II shows the differences in the amount of the various sizes in the different flue dusts.

TABLE II—RESULTS OF SCREEN-SIZING TESTS OF FLUE DUSTS

Screen Size, Mesh	Per Cent by Weight						
	No. 1	No. 3	No. 5	No. 6	No. 4	No. 2	No. 7
Plus 8.....	0.0	0.1	0.4	1.9	7.0	6.9	8.4
—8 —10....	0.0	0.1	0.8	1.5	2.4	6.0	6.6
—10 —14...	0.0	0.3	1.5	1.9	2.8	6.9	8.0
—14 —28...	0.0	5.3	14.3	12.8	13.0	27.4	28.1
—28 —35...	0.5	10.2	13.4	14.1	12.2	15.5	14.4
—35 —48...	3.6	20.8	16.2	19.0	16.3	14.8	13.5
—48 —65...	11.8	19.6	12.6	17.0	14.0	9.2	8.0
—65 —100..	20.4	15.8	11.0	13.5	12.5	5.7	5.7
Minus 100..	63.7	27.8	29.8	18.3	19.8	7.6	7.3
Total.....	100.0	100.0	100.0	100.0	100.0	100.0	100.0

The relation between the screen sizes and composition of the different flue dusts is not definite because the furnace operations are so irregular. The screen analysis and chemical content of a flue dust are affected by several factors such as: 1—Blast pressure; 2—kind and grade of ores charged to the furnace; 3—size of particles in the ore; 4—height of stock-line; 5—amount of coke in charge; 6—size of coke particles; 7—amount of lime added to charge; 8—size of limestone particles.

The laboratory tests include "magnetic" assays of the flue dusts and the large-scale tests were of three types—dry-magnetic separation for coarse ore, wet-magnetic cobber for coarse ore, and wet-magnetic logwasher for finely crushed ore.

Conclusions from Tests.

The following conclusions were derived from these experiments:

1—The high content of gangue in the average flue dust of the Birmingham district makes it unfit to treat in the same manner as those of other districts where direct sintering is sufficient to produce a satisfactory product.

2—The charge and the operating conditions at the various furnaces from which samples were obtained are so variable that no single sample of flue dust can be taken as representative. Likewise, samples from the same furnace varied greatly in physical characteristics and in chemical composition. Hence, a successful concentration process must be capable of operating under a varying feed.

3—The coke can readily be removed by gravity concentration, for example, hydraulic classification. However, after the coke has been removed the low-grade iron ore remaining is not amenable to satisfactory concentration by ordinary methods. This is due primarily to intimate interlocking which requires grinding to 100 mesh to liberate the hematite from the gangue. Material of such fineness is difficult to handle by gravity concentration.

4—In the number of the samples, hot reducing gases in the blast furnace or in the dust catcher had converted the iron minerals from hematite or limonite into magnetite. When such an alteration had taken place, a good separation of the iron mineral from the gangue can be obtained by use of magnetic concentration machines.

5—Magnetic concentrators of various kinds, such as a magnetic wet cobber, a magnetic dry concentrator, and a magnetic log-washer, were used on flue dust in which the iron mineral had been converted into magnetite. The first two machines are built to handle coarse material and the log-washer is designed to handle fine material. The results obtained with these different machines show that a good concentrate and a high recovery can be made by the dry concentration or the wet cobber without preliminary crushing. It is doubtful whether the added expense of fine grinding would be justified by the higher grade of concentrate obtainable in the magnetic log-washer.

6—When a large proportion of iron is in the form of magnetite, a magnetic cobber will give excellent results at a low cost and requires a relatively simple installation.

Book Review

Corrosion: Causes and Prevention. By F. N. Speller. 621 pages and 125 illustrations. McGraw-Hill Book Company, New York. 1926. Price, \$6.

The author of this work is director of the Metallurgical Department of the National Tube Company and is well known through his research of corrosion, and the term "Spellerizing" has arisen therefrom. The subtitle to this book is "An Engineering Problem," and in his introductory sentence the author says, "The wastage of metals due to corrosion has now become an important engineering problem." But it is more than that—it is a physico-chemical problem on which many are working and a great deal has been and is being published.

There is no need in this review to attempt any discussion of the theory of corrosion or of the ravages on

metals thereby. Mr. Speller devotes 44 pages to theory, and concludes that the electrochemical theory is now generally accepted in explanation of the fundamental reactions and factors of corrosion, also the application of this theory to the practical solution of the corrosion problem has been of great assistance. The number of factors involved and their effect on each other are sometimes bewildering. Some of the "secondary" factors, such as the protection afforded by films and coatings, often exert a predominating influence and may, in fact, stop the primary reactions entirely. These factors are often independent of the initial corrosion reactions. The important consideration is to determine the effect of these factors and their relation to each other.

As it is possible that the process of manufacturing iron and steel may have an influence on the corrosion of these metals in service, Mr. Speller in 40 pages describes every step of manufacture, from the ore to the cold—and hot—working of the products. He concludes, in part, that it is of great advantage for one organization to have complete control of all operations from the mining of the ore to the finished product. In this way the quality can be controlled and the defects that arise through poor mill practice will be reduced to a minimum. Probably no steel which is highly resistant to corrosion and possesses the requisite physical properties can be made for general use without a considerable increase in cost. There has been much development of such steels, but in most cases until the cost of corrosion-resistant steels becomes greatly reduced, it will be found much more economical to utilize preventive measures and control the causes of corrosion. For most purposes, ordinary bessemer and open-hearth steel, for economic reasons, will continue to fill the demand for some time to come. Therefore, in considering the immediate solution of the corrosion problem from a practical standpoint, it becomes important to study the action and control of external factors which initiate and support corrosion. Thereupon, in the two succeeding chapters, the author discusses the influence of factors internal to the metal (the composition), and the influence of factors external to the metal (classification of corrosion).

In 34 pages the subject of testing is covered. Here it is rightly stated that much of the misapprehension and difference of opinion concerning the relative durability of different forms of iron is due to improper tests and misinterpretation of observations, and many tests have been devised more with the idea of getting quick results than of properly controlling the essential variables so that they will be analogous to those in service. In this chapter is emphasized the need for a clear appreciation of all the factors involved in service, although it is possible to classify the various kinds of corrosion into a few types and design short-time tests for each type which will indicate the results to be expected from bare or coated metal under definite conditions of service.

The last chapter of Part I, General Principles, covers 38 pages and deals with the relative corrosion of ferrous metals. This is shown by means of photographs, curves, and tables. It is concluded that external factors predominate and determine the rate of natural corrosion with ordinary iron and steel; composition is of minor importance in corrosion under water and relatively important in the air. The conclusions regarding wrought iron versus steel and cast

iron versus steel or wrought iron are of considerable interest and too long to give in this review.

Part II of this book consists of 8 chapters of 290 pages on Preventive Measures—prevention of corrosion in the atmosphere, under water, in closed water system, in high-pressure steam plants, in steam and hot-water treating systems, by chemicals, underground, and stray-current electrolysis. Each of these chapters discusses the causes of corrosion under these conditions and gives tried and suggested remedies.

As a whole, on a highly technical subject, Mr. Speller's book will be found of great interest and value to the physical chemist and to the man who comes in actual contact with the ravages of corrosion and has either to try and prevent it or replace corroded materials. It is easy to read and follow. The author realizes the value of definite conclusions and has them at the end of each chapter—clear and concise. Several chapters have either been written in collaboration with other specialists in this problem or have been reviewed by them and suggestions added. There are many authoritative references and a selected bibliography. Something good was expected from Mr. Speller and it is to be found in this work.

M. W. von Bernewitz.

Protective Coatings for Metals—A Correction

A short series of articles on "Protective Coatings for Metals" under the signature of James A. Aupperle, Middletown, Ohio, appeared in the June, July, and August issues of The Blast Furnace and Steel Plant.

Mr. Aupperle only wrote the series that dealt with galvanizing, tinning, enameling, and painting. Through an oversight on the part of the editor, the entire series of articles were credited to Mr. Aupperle as the author, whereas credit should have been given to the following:

Mr. L. E. Eckelmann, Pyrene Manufacturing Company, Newark, N. J., for his article on Parkerizing.

Mr. C. J. Kirk, United States Sherardizing Company, New Castle, Pa., for his article on Sherardizing.

Mr. A. W. Crawford, H. H. Robertson Company, Pittsburgh, Pa., for his article on Asbestos Protected Metal.

We wish to take this opportunity in extending our apologies for our failure to give due credit.

—The Editor.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, ETC., OF

The Blast Furnace and Steel Plant

[Required by the Act of Congress of August 24, 1912]

Name of Publication: The Blast Furnace and Steel Plant, published monthly at Pittsburgh, Pa. [Report for October 1, 1926.]

Publisher—The Andresen Co., Inc., 108 Smithfield St., Pittsburgh, Pa.
Editor—D. L. Mathias, 108 Smithfield St., Pittsburgh, Pa.
Managing Editor—W. A. Covert, 108 Smithfield St., Pittsburgh, Pa.
Business Manager—M. M. Zeder, 108 Smithfield St., Pittsburgh, Pa.

Names and Addresses of stockholders holding 1 per cent or more of total amount of stock:

L. L. Carson, 108 Smithfield St., Pittsburgh, Pa.
F. C. Andresen, 709 House Bldg., Pittsburgh, Pa.
C. J. Keller, 5840 Solway St., Pittsburgh, Pa.
M. M. Zeder, 108 Smithfield St., Pittsburgh, Pa.
R. H. Thiess, 520 California Bldg., Los Angeles, Calif.

Known bondholders, mortgagees, and other security holders holding 1 per cent or more of total amount of bonds, mortgages or other securities: None.

M. M. ZEDER, Business Manager.

Sworn to and subscribed before me this 17th day of October, 1926.

CHAS. A. SEIBERT, Notary Public.

(My commission expires March 6, 1927.)

PERSONALS

L. D. Mercer has been placed in charge of sheet sales for the Central Alloy Steel Corporation, having served in a similar capacity for the United Alloy Steel Corporation. He will be under direction of J. H. Schlendorf, director of sales, Massillon, Ohio.

* * *

William H. Schulte, for six years with the American Foundry Equipment Company, has resigned to become general superintendent for S. Cheney & Son, Manlius, N. Y., gray iron founder. He formerly was superintendent of foundries for the Arcade Manufacturing Company, Freeport, Ill.

* * *

Clarence R. Rupp, auditor and purchasing agent for the New York Central Iron Works, Inc., Hagerstown, Md., has resigned and become general manager for the Aetna Iron & Steel Company, Jacksonville, Fla. He formerly was connected with the Central Iron & Steel Company, Harrisburg, Pa.

* * *

Frank L. Gibbons, for several years sales manager in the Cleveland district for the Central Steel Company, Massillon, Ohio, has been appointed to the same position for the Central Alloy Steel Corporation, recently formed by merger of the United Alloy Steel Corporation and the Central company. R. B. Kelly and N. L. Schneider, formerly in charge of sales for the United Alloy Corporation in Cleveland, have been made assistant managers of sales at Cleveland.

* * *

C. H. Johnson has been appointed engineer in the service department of the Timken Roller Bearing Company, Canton, Ohio. He will have direct charge of the installation of Timken bearings in automotive and industrial applications.

* * *

McDonald C. Booze, formerly senior fellow of the American Refractories Institute's fellowship, Mellon Institute of Industrial Research, and now vice-president in charge of research and development for Charles Taylor Sons, Cincinnati, is convalescing from a serious illness.

* * *

Ernest B. Talkes, formerly machine-shop superintendent in the Indiana Harbor Works of the Inland Steel Company, Chicago, has been made general master mechanic of the Indiana Harbor plant. He succeeds Frank J. Werner who has been appointed superintendent of the splice-bar and tie-plate department.

* * *

G. A. White has severed his connections with the Otis Steel Company, Cleveland. He was assistant to R. H. Clarke, vice president in charge of operations, and his duties included metallurgical work.

* * *

Louis A. Way has been made president of the Sharon Foundry Company, Wheatland, Pa. For many years he was superintendent of the Duquesne Steel Foundry Company, and later held the same position with the Lewis Foundry & Machine Company. He more recently was connected with the Mesta Machine Company.

John R. Blair has been appointed manager of sales of the Pittsburgh Steel Products Company, Pittsburgh, to succeed Charles F. Palmer, resigned.

* * *

P. Roberts Baker has been appointed assistant to the president of the Lukens Company, Coatesville, Pa., effective September 13. He previously had been manager of plant operations.

* * *

William H. Warren, general superintendent since 1922 of the Trumbull Steel Company, Warren, Ohio, has been appointed general superintendent of the Lukens company, a position just created.

OBITUARIES

Dr. Auguste J. Rossi, consulting chemist for the Titanium Alloy Mfg. Company and the Titanium Pigment Company, Inc., both of Niagara Falls, N. Y., died September 1 at his home in that city.

* * *

Samuel H. Squier, Sr., aged 61 years, president of the Squier-Rix Company, of Milwaukee, founder of the Milwaukee Electric Crane & Mfg. Company, and for 25 years secretary of the Pawling & Harnishfeger Company, died several weeks ago at his home in Milwaukee.

TRADE NOTES

The International Steel & Iron Company, 3936 South Lincoln Street, Chicago, Ill., has plans for the immediate erection of a one-story and basement addition to its plant at Fifty-first Street and Kedzie Avenue, to be 175 x 335 ft., estimated to cost close to \$200,000, with equipment. S. Scott Joy, 2001 Pershing Road, is architect.

* * *

The American Sheet & Tin Plate Company, Pittsburgh, Pa., a subsidiary of the United State Steel Corporation, New York, has authorized plans for extensions and improvements in its mills at Gary, Ind., to be carried out over a period of months. The work will consist of the erection of new tin-plate mills and the installation of machinery to advance the present capacity about 50 per cent. The plant is now giving employment to more than 3500 workers and this number will be advanced to 5000 persons and more, with the completion of the project. The entire expansion is expected to cost in excess of \$8,000,000.

* * *

The Cleveland Steel Company, Cleveland, Ohio, has discontinued operations permanently at its local mills, and will place the property on the market. The works have been in service since 1853, the present company, formed in 1893, succeeding two previous companies. The plant includes a sheared plate mill, with roughing and finishing stands. It is understood that the company is negotiating for the sale of the property to interests which propose to resume operations along the former line of output.

The Griffin Wheel Company, St. Paul, Minn., manufacturer of steel car wheels, is said to be planning the early rebuilding of the portion of its local plant at Stillwater and Phalen Avenues, recently destroyed by fire with a loss approximating \$150,000, including equipment. The reconstruction is expected to cost close to a like sum. Headquarters are at 410 North Michigan Avenue, Chicago, Ill.

* * *

The Interstate Iron & Steel Company, Chicago, Ill., has arranged for a bond issue of \$4,000,000, a portion of the proceeds to be used for expansion. The company is now operating three plants in the Chicago district, with combined capacity of about 400,000 tons of finished material per year, including carbon steel and alloy steel ingots, blooms and billets, iron and steel bars, shapes, etc. Paul Llewellyn is president.

* * *

The Inland Steel Company, Chicago, Ill., is pushing work on the electrification of its plant at Indiana Harbor, Ind., and has now closed down a number of units to complete the program at the earliest possible date. The portions of the plant to be changed to electric-operation include the 24-inch bar mill, bloomer mill and the sheet mill, as well as eight open hearths in Plant No. 1. Generators and auxiliary electrical apparatus will be set up at once. It is said that the complete electrification of the plant will effect an increase of about 15 per cent in production speed.

* * *

The Rome Strip Steel Company, Rome, N. Y., recently organized with a capital of \$150,000, has work under way on the installation of equipment for its proposed new plant, to be devoted to the production of cold-rolled strip steel. The machinery will consist of 10 and 12-inch mills, and auxiliary apparatus. It is purposed to develop an output of about 1,000 tons of material per month. It is expected to have the plant ready for service at an early date. H. B. Hinman, formerly connected with the Trumbull Steel Company, Warren, Ohio, is general manager.

* * *

The United States Steel Products Company, New York, a subsidiary of the United States Steel Corporation, has included arrangements for a controlling interest in the Compania de Maestranzas y Galvanizacion, Chile, and plans for extensive operations in this section. The acquired company has a plant at Caleta Abarca, on Valparaiso Bay, near the city of Vina del Mar. The main works is used for steel fabricating, galvanizing and affiliated operations, with a shipyard adjoining for the building and repairing of barges and other craft. The purchasing company plans to remodel and improve this plant, and will make extensive additions in present facilities. The structural steel division will be increased, and considerable new machinery installed. The works will be used for fabricating material for buildings, assembling and repairing of railroad cars, and other similar operations. The galvanizing department, also, will be subjected to similar enlargement, the new owner intending to develop this branch for the complete manufacture of galvanized steel sheets of first quality. Likewise, considerable new machinery will be installed for this purpose.

* * *

The Columbian Steel Tank Company, 1601 West Twelfth Street, Kansas City, Mo., has tentative plans under advisement for the erection of a new one-story

addition to its plant, reported to cost close to \$50,000, with equipment. It is purposed to begin work at an early date. The company is also said to have preliminary plans under consideration for the erection of a new plant unit, estimated to cost more than \$500,000, with machinery.

* * *

The former plant of the Atha Steel Works, Chapel Street and Lister Avenue, Newark, N. J., later known as the Titan Steel Works, has been acquired by the Hanson-Van Winkle Company of the same city, manufacturer of electro-plating equipment, generators, dynamos and kindred products, and will be remodeled and improved by the new owner for expansion. New machinery will be installed. It is expected to have the property ready for occupancy at an early date.

* * *

The Casey-Hedges Company, Chattanooga, Tenn., manufacturer of steel plate products, including tanks, etc., has plans in preparation for a proposed new addition to its plant to be used exclusively for the manufacture of steel barrels and drums. The extension will be 100 x 500 ft., and is reported to cost in excess of \$100,000, including machinery.

* * *

The Fansteel Products Company, North Chicago, Ill., has completed plans and will proceed with the erection of a new addition to its plant on State Street. It will be two-story and basement, 100 x 100 ft., estimated to cost approximately \$80,000, with equipment. Frank D. Chase, Inc., 720 North Michigan Avenue, Chicago, is architect. J. M. Troxel is president.

* * *

The Pullman Company, Michigan and Adams Avenues, Chicago, Ill., has plans for the construction of a new addition to its steel car manufacturing plant on Langley Avenue, near One hundred and eleventh Street. It will be one-story, brick and steel, estimated to cost more than \$550,000, with machinery.

* * *

The Bethlehem Shipbuilding Corporation, Baltimore, Md., a subsidiary of the Bethlehem Steel Corporation, Bethlehem, Pa., has acquired property adjoining its plant on the Key Highway, and will use same for expansion. Plans will be prepared for new buildings and other structures, estimated to cost more than \$2,000,000, with machinery.

TRADE PUBLICATIONS

Refractory Cement—General Refractories Company, Philadelphia, has issued a leaflet describing a high temperature cement it is producing for use in furnaces and similar places where high temperature is met.

* * *

Special Steel—Jones & Laughlin Steel Corporation has issued a bulletin featuring a new free-cutting open-hearth steel adapted to case hardening and for forging where machinability is important. Statements of users for various purposes are presented.

* * *

Stokers—A traveling grate stoker to burn a wide range of fuels, especially adapted to small sizes of anthracite and coke breeze, is featured in a bulletin

by the Combustion Engineering Corporation, New York. Details of construction are shown in illustrations and a table showing evaporative tests is included.

* * *

Engine Indicator—Bacharach Industrial Instrument Company, Pittsburgh, has issued a bulletin describing a type of engine indicators it is manufacturing. Value of indicator readings is discussed and the bulletin is illustrated fully to show the construction and operation of the indicator.

* * *

Circuit Breakers—Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa., has issued several revised leaflets covering its carbon circuit breakers and oil circuit breakers. Application, construction and operation of the several types are discussed.

* * *

Skip Lift—Application of the skip hoist principle to the elevation of bulk materials in industrial use is covered in a bulletin by the R. H. Beaumont Company, Philadelphia. The lift may be automatic, semi-manually operated.

Conference on Bituminous Coal

The Carnegie Institute of Technology announces a Conference on Bituminous Coal to be held at Pittsburgh, November 15 to 19. The purpose of the meeting is to consider new uses for bituminous coal and to present the results of recent investigations of coal that are concerned with improved methods of utilization and combustion.

A number of distinguished European scientists will take part, as well as some of the best-known American fuel technologists and engineers. The program will include the discussion of the manufacture of substitutes for gasoline from coal, complete gasification of coal, high temperature distillation, low temperature distillation, coal tar products, power, smokeless fuel, fertilizers, etc.

Among those who have accepted invitations to be present and to speak are: Dr. Friedrich Bergius, of Heidelberg, Germany, inventor of the Bergin method of the production of oil from coal; Professor Franz Fischer, Director of the Institute of Coal Research, Mulheim-Ruhr, Germany; Dr. C. H. Lander, Director of Fuel Research of the Department of Scientific and Industrial Research, London; Dr. R. Lessing, Consultant in Fuel Technology, London; Geoffrey M. Gill, Consulting Engineer and Gas Specialist, London; Harald Nielsen, inventor of the L. and N. Process, London; General Georges Patart, of France, inventor of a process for making methyl alcohol from coal; Marius R. Campbell, U. S. Geological Survey; A. C. Fieldner, U. S. Bureau of Mines; John M. Weiss, Chemical Engineer, New York, N. Y.; C. J. Ramsburg, vice president, The Koppers Company, Pittsburgh; S. W. Parr, Professor of Applied Chemistry, University of Illinois; C. V. McIntire, of the Consolidated Coal Products Company, Fairmont, W. Va.

Papers will be presented by a number of other American and European technologists. Special attention will be devoted to the discussion of recently developed processes which are in actual operation. An Advisory Board includes the following men of affairs: Hon. Andrew W. Mellon, John Hays Hammond, Otto H. Kahn, Charles M. Schwab, Samuel Insull, E. M. Herr, and Dr. Frank B. Jewett.

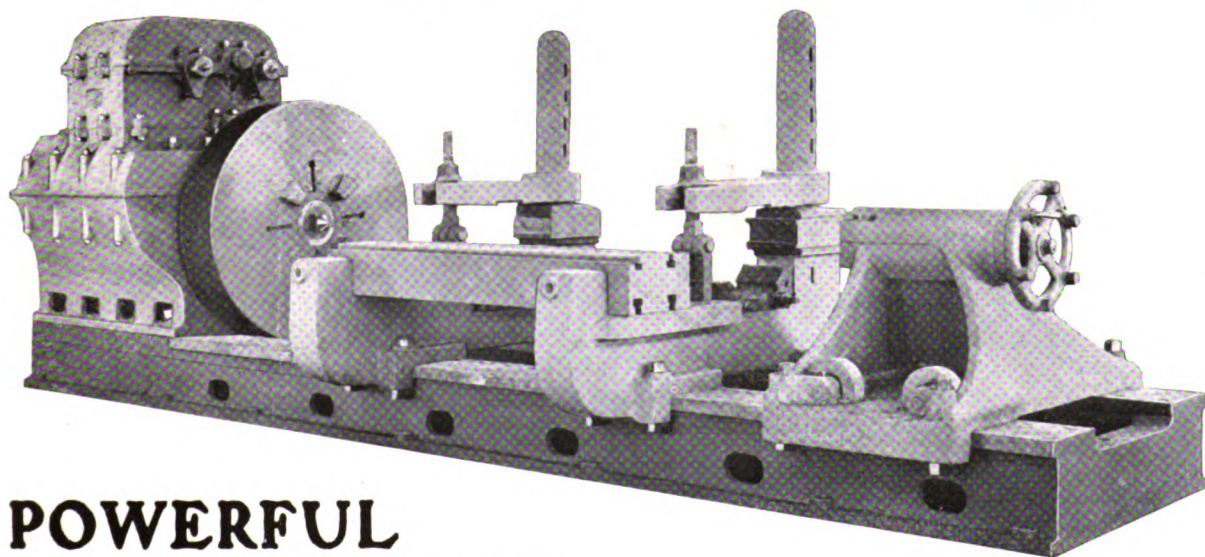
The Blast Furnace *and* Steel Plant

Member of the Audit
Bureau of Circulations

PITTSBURGH, PA., OCTOBER, 1926

Entered as second class mail matter at Pittsburgh,
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